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6 CONTAINER/CHASSIS IDENTIFICATION REPORTING SYSTEM (CCIRS)

INTERFACE AND FEASIBILITY ASSESSMENT.

9 Rept. for Dec 77 — Nov 78,

by

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K. J. Dean
H. H. Ellis, Jr.
W. H. Chen

T. J. White

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RESEARCH AND DEVELOPMENT COMMAND
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This study was undertaken to determine the feasibility of integrating the Container/Chassis Identification Reporting System (CCIRS) with existing and projected cargo movement-management subsystems of the Terminal Operation and Movement-Management Systems (TOMMS) and to assess the operational feasibility of the CCIRS. Specific subsystems considered were: Department of Army Standard Port System (DASPS), Visibility of Intransit Cargo (VIC) and Highway Fleet Management System (HFM).
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The major finding of the study was that source-data automation equipment, such as the CCIRS, is cost effective in a peacetime environment and is a viable concept for providing real-time, error-free data. The benefit of the surge capability inherent to CCIRS in a wartime transition situation was recognized during the course of this study, but the contribution to the outcome of a military conflict was not quantified. Additional findings and conclusions are presented.

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SUMMARY

This study was undertaken to determine the feasibility of integrating the Container/Chassis Identification Reporting System with existing and projected cargo movement-management subsystems of the Terminal Operation and Movement-Management System and to assess the operational feasibility.

Specific subsystems considered were: Department of Army Standard Port System, Visibility to Intransit Cargo, and Highway Fleet Management System. Other technical objectives included the determination of performance requirements and hardware specifications, identification of other potential Army applications for CCIRS, and examination of other development alternatives.

The need for a more effective movement-management system has been a concern of the Department of Army (DA) since the 1950's. The concern was underlined and prioritized as a result of the logistics problems experienced during Vietnam and the expectation that such problems would persist in future conflicts.

This need was addressed by several studies, referred to in this report, conducted under the auspice of DA to identify and resolve the problems within the present movement-management systems. Many of the studies identified the lack of an improved, automated, movement-management system based on real-time data as one of the major obst.. les in achieving a more effective system. The general recommendation was that new systems should make extensive use of automatic data-processing equipment and real-time data.

In response to these recommendations, DA, through designated commands, initiated a phased development and implementation program on an advanced movement-management system called DAMMS. The DAMMS System in conjunction with a revamped DASPS is projected to provide the necessary framework to support a fully automated movement-management system that will eventually be adapted as an Army standard system for worldwide application.

Additionally, it was noted that source-data automation should be used to complement the standard system. The recommended method to accomplish source-data automation was a remote, electromagnetic, label-reading device. Based on this approach, developmental efforts initiated at MERADCOM resulted in the present CCIRS system.

The CCIRS is an automated information reporting and processing system consisting of a label, an interrogator, and a data buffer which can be used in conjunction with TOMMS to maintain visibility over intransit cargo or transportation assets in CONUS and Theaters of Operations. The label is a microwave transponder that can be encoded with an identification number and attached to cargo and transportation assets such as containers and trucks. The interrogator, positioned to monitor the flow of assets as desired, activates the label and transmits the encoded information to a data buffer. The data buffer stores the information and, at some prescribed interval, forwards it to a central computer facility along with the time and location. The information would be used for the control and movement-management of cargo and transportation assets.

The CCIRS was envisioned to provide real-time, error-free data in three functional modes of operation: line-side, mobile, and gate.

The gate and line-side modes are operated for the purpose of monitoring the movement of transportation assets and cargo. The mobile mode, in general, is used to record stationary cargo and transportation assets being held in terminals and marshaling yards.

The range requirements of the interrogator, capacity of the data buffer, and RAM (Reliability, Availability, Maintainability) characteristics are descirbed in paragraphs 13 and 14. The following requirements will be adequate for the three modes of operation:

Range: 52 feet.
Buffer capacity: 9×10^5 bits.
Availability: 0.999 percent.
MTBF: 3000 hours.

The maximum range requirement was based on the line-side mode of operation with the interrogator monitoring one-way traffic on an 8-lane superhighway (4 lanes each direction). This situation would occur rarely, if ever, and then only at the sacrifice of performance coverage because of line-of-sight blockage to the interrogator resulting from multilane traffic patterns. Performance degradation predictions are presented in paragraph 13 based on a parametric analysis of typical US highway traffic densities. The gate and mobile modes of operation do not influence the interrogator's basic range requirements much beyond 20 to 25 feet. The relatively slow speeds normally expected in these modes could be used readily to limit passing ranges to within acceptable limits by the employment of access control lanes.

The buffer capacity of 9×10^5 bits was based on the need to monitor 9300 containers at a single time. This figure was based on the assumption that it would be desirable to interrogate and store at least one-half of the maximum capacity of the larger marshaling areas. An exhaustive field survey of existing facilities will be required to further refine the capacity of the data buffer. Data reporting intervals in excess of 2 to 3 hours would be required before the line-side mode of operation would increase the storage capacity of the data buffer.

The relationship between availability and MTBF is analyzed parametrically in paragraph 14. Based on an overall system performance of 99 percent coverage, an interrogator availability of 0.9975 is required to meet the 25-percent error budget allocated to the interrogator. Then, for restoration times of less than 1 hour (repair plus response time), an interrogator MTBF on the order of 200 to 400 hours is sufficient to meet system performance requirements. However, from a user's viewpoint relative to maintenance, cost, and personnel, Mean-Time-Between-Failures (MTBF) values in this range are too small for practical considerations. At 400 hours, annual maintenance costs would run nearly 100 percent of the original equipment cost rather than the normally accepted value of 10 to 15 percent. MTBF values in the range of 2000 to 3000 hours are more realistic relative to acceptable maintenance costs and can still be demonstrated readily during development without requiring extensive test hours. Availability and MTBF values are thus driven by cost considerations rather than operational factors.

The primary interface between CCIRS and the Terminal Operation and Movement-Management System was evaluated relative to three subsystems: Department of Army Standard Port System, Visibility of Intransit Cargo, and Highway Fleet Management. These particular systems were chosen because of their need for error-free, real-time data which CCIRS could provide. VIC and HFM are subsystems of DAMMS; DASPS and DAMMS, in turn, constitute TOMMS. The only interface required was found to consist of a cross-reference file at the central computer facility to relate container/chassis numbers to a particular transportation control number.

In a peacetime environment, CCIRS was shown to be cost effective, recovering its capital investment cost in slightly less than 8 years. The ground rules and assumptions upon which this recovery period is based are presented in paragraph 16. Other benefits and cost reductions that would accrue from an improved throughput were not considered in this determination. In the opinion of the study team, these other benefits were considered sufficient by themselves to warrant continued development of CCIRS. The capital leverage available to Department of Defense (DoD) by equipping part of the commercial container fleet with source-data automation labels is an attractive investment strategy considering the scarcity of capital resources in the

peacetime environment. The capital leverage expected is in the range of $200 to $300 per container for each dollar expended on labels. Relative to the Army's over-all procurement plan, CCIRS was found to represent less than 1.5 percent of Army's planned expenditures for container-oriented equipment through fiscal year 1985. However, if the $13.2-million capital investment required for CCIRS continues to be a major obstacle, the CCIRS should be evaluated in the context of the total benefits to be derived in a wartime environment including the transition phase.

The peacetime Army is functioning today without source-data automation and obviously can continue to do so in the future even though this may represent a less-than-optimum situation. The need for source-data automation must rest finally on whether the logistics system can or cannot support the field Army during wartime. Existing simulation tools are capable of quantifying the performance of the logistics systems with and without source-data automation and have been used in recent years to study areas such as the Direct-Support System in wartime transition and the Com-bat Service Support. The magnitude of the financial resources and the time required to implement such a study approach, however, are large in comparison to the life-cycle costs involved (5 to 10 percent). A serious issue which should be resolved is whether it is necessary to quantify the wartime benefits in view of recent military experience in Vietnam. The published literature reviewed is oriented in its entirety toward the positive view that automated, movement-control procedures are essential for the modern battlefield.

Other applications for CCIRS were examined but none was found sufficient to warrant continued development. The findings were presented to the Logistics Center (LOG CTR), Fort Lee, Virginia, in August 1978. A subsequent review by LOG CTR concluded that a requirement for CCIRS no longer existed. Development efforts have been terminated accordingly. The rationale supporting the LOG CTR position is presented in paragraph 19.

The major conclusions are summarized as follows:

a.   Continued development of CCIRS is consistent with Army policy.

b.   Based on a 300-station system, CCIRS is cost effective for both real-time and near-real-time source-data automation in the peacetime environment.

c.   CCIRS has a surge capacity of significant benefit for effective wartime transition.

d.   Label installation costs on commercial containers may be covered by the Maritime Acts.

e.   Technical requirements such as range and storage capacity are well within the current state-of-the-art.

f.   CCIRS is communications-dependent; however, digital-burst-transmissions techniques could drastically reduce the communication workload compared to the current practice of voice transmission.

g.   RAM issues are dependent on cost rather than performance accuracy and operational factors.

h.   The Defense Transportation System represents the largest and most beneficial area for application of the CCIRS.

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ABBREVIATIONS AND ACRONYMS

AATCO – Army Air Transportation Coordinator

ACODS – Army Container-Oriented Distribution System

ACofS – Assistant Chief of Staff

ADP – Automatic Data Processing

AFCSS – Army in the Field Container System Study

ALMICS – Automated Logistics Management and Inventory Control System

AMC – Army Materiel Command

AMCA – Advanced Materiel Concept Agency

APOD – Aerial Port of Debarkation

APOE – Aerial Port of Embarkation

ARA – Assigned Responsible Agency

ASD – Assistant Secretary of Defense

ATMCT – Air Terminal Movement Control Teams

AUTODIN – Automatic Digital Network

AUTOSTRAD – Automated Systems for Transportation Data

Bde – Brigade

BENELUX – Belgium, Netherlands, Luxembourg

CADS – Containerized Ammunition Distribution System

CCIRS – Container-Chassis Identification and Reporting System

CDC – Combat Developments Command

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CDI – Cargo Disposition Instructions

COMMZ – Communications Zone

CONUS – Continental US

COSCOM – Corps Support Command

CRT – Cathode Ray Tube

CS3 – Combat Service Support System

CTA – Cargo Traffic Analysis

DA – Department of Army

DAAS – Defense Automatic Addressing System

DAMMS – Department of Army Movement-Management System

DASPS – Department of Army Standard Port System

d.c. – Direct Current

DCSLOG – Deputy Chief of Staff for Logistics

DCU – Daily Capability and Utilization Report

DFSR – Detailed Functional System Requirement

DIIVS – Defense Intransit Item Visibility System

DISR – Daily Installation Situation Report

DMMC – Division Materiel Management Center

DoD – Department of Defense

DPU – Data Processing Unit

DS – Direct Support

DSU – Direct-Support Unit

DTS – Defense Transportation System

ENCOM – Engineer Command

ESSG – Engineer Strategic Studies Group

ETA – Estimated Time of Arrival

FAD – Functional Area Description

FMO – Forward Movement Office

FINDER – Theater Logistics Intelligence File

G&A – General & Accounting

GS – General Support

GSU – General-Support Unit

HFM – Highway Fleet Management

HFMS – Highway Fleet Management System

HHC – Headquarters and Headquarters Company

HRT – Highway Regulating Team

ID – Identification

IOC – Initial Operational Capability

ISO – International Standardization Organization

ITMIS – Integrated Transportation Management Information System

JLOTS – Joint Logistics Over-the-Shore

JLRB – Joint Logistics Review Board

JTB – Joint Transportation Board

KCS – Kaiserslautern Cold Storages

KAD – Kaiserslautern Army Depot

LIF – Logistics Intelligence File

LOG CTR – Logistics Center

LOGMARS – Logistics Application of Automated Marking and Reading Symbols

LOTS – Logistics-Over-the-Shore

MAC – Military Airlift Command

MCA – Movement Control Agency

MCC – Movement Control Center

MEDCOM – Medical Command

MERADCOM – Mobility Equipment Research and Development Command

MILSTAMP – Military Standard Transportation and Movement Procedures

MILSTRIP – Military Standard Requisitioning and Issue Procedures

MILVAN – Military-Owned Demountable Container

MMC – Materiel Management Center

MOTCA – Motor Transport Clearance Authority

MSC – Military Sealift Command

MTBF – Mean Time Between Failures

MTMC – Military Traffic Management Command

MTSR – Military Trailer Status Report

MTTR – Mean Time to Repair

NICP – National Inventory Control Point

NLT – No Later Than

OCONUS – Outside Continental US

PERSCOM – Personnel Command

PM-ACODS – Project Manager: Army Container-Oriented Distribution System

POE – Port of Embarkation

POD – Port of Debarkation

PRS – Passenger Reservation System

RAM – Reliability, Availability, Maintainability

RDD – Required Delivery Date

ROC – Required Operational Capability

RORO – Roll On/Roll Off

RPF – Remote Process Facility

RTO – Rail Transport Officer

SAAS – Standard Army Ammunition System

SALS – Standard Army Logistics System

SDA – Source-Data Automation

SEAMIST – Seavan Manifest Information System

SEAVAN – Commercial or Government-Owned (or Leased) Shipping Container

SPS – Standard Port System

TA – Theater Army

TAACOM – Theater Army Area Command

TASTA – The Administrative Support Theater Army

TCMD – Transportation Control and Movement Document

TCN – Transportation Control Number

TMA – Transportation Movement Answer

TMARS – Table Maintenance and Retrieval System

TMI – Transportation Movement Inquire

TMO – Transportation Movements Officer

TMR – Transportation Movements Release

TMSL – Trailer Movement Status Logs

TOMMS – Terminal Operations and Movements-Management System

TPA – Transportation Performance Analysis

TRAMMS – Transportation, All-Mode, Movements-Management System

TRANSCOM – Transportation Command

TSP – Transship Point

TTP – Trailer Transfer Point

UK – United Kingdom

USACSC – US Army Computer Systems Command

USAFE – US Air Forces in Europe

USALCO – US Army Logistic Control Office

USALOGC – US Army Logistic Center

USAREUR – US Army Europe

USARPAC – US Army Pacific

USATRANSCOMEUR – US Army Transportation Command, Europe

VIC – Visibility of Intransit Cargo

VIMS – Vertical Integrated Management of Substance

WPOD – Water Port of Debarkation

WSEG – Weapons Systems Evaluation Group

WTCA – Water Terminal Clearance Authority

CONTAINER/CHASSIS IDENTIFICATION REPORTING SYSTEM (CCIRS)

INTERFACE AND FEASIBILITY ASSESSMENT

I. INTRODUCTION

1. **Purpose.** The purpose of this study is to identify and define the use and application of the Container/Chassis Identification and Reporting System in a theater of operations and to determine system compatibility and interfaces with existing cargo control and reporting systems.

2. **Objectives.** The specific objectives of the study of CCIRS were:

a. Identify techniques currently used for reporting and controlling the movement of cargo in the Department of Army Standard Port System, the Cargo Module of Visibility of Intransit Cargo, and the Highway Fleet Management System used by the 37th Transportation Group, Europe.

b. Determine systems interfaces and the qualitative enhancement to be expected by introducing an identification reporting system.

c. Examine the performance requirements. and hardware specifications.

d. Identify other potential Army applications for the CCIRS.

e. Examine other development alternatives.

3. **Overview.** This report consists of five sections including the Introduction. The historical aspects of automated logistic management support are reviewed in order to present some of the rationale which lead the US Army to develop source-data automation equipment. A description of the CCIRS hardware, its functions, and its supporting software is included in Section II. Although not a direct part of the study, descriptions of the Defense Transportation System and the Organization and Mission of Transportation Support Units in a Theater of Operations are in Section III because they form the overall framework in which the source-data automation equipment must operate. The management systems presently used in Europe are described in detail in Section IV. Section V, DISCUSSION, attempts to bring together the pertinent factors described in these four sections in order to delineate the basic study objectives. These include the benefits and advantages that are expected to be derived by introduction of the equipment for specific applications, an analysis of technical requirements including range and data-storage capacity, essential RAM characteristics, and a cost benefit comparison of alternate techniques currently available.

4. **Background.** The CCIRS is based on the concept of automatically monitoring the flow and movement of containers and other transport assets such as chassis, pallets, or tractor trailers through key nodal points of a transportation distribution network. A cargo traffic management system is defined as the personnel, equipment, and information systems involved in the movement-management of cargo so that:

● Transportation assets may be scheduled and utilized effectively in meeting the transportation requirements of the user.

● Effective action may be taken during cargo transit to clear, expedite, hold, direct, return, or change mode of transportation.

● Queries on cargo status may be responded to rapidly.[1]

The lack of identification and location of supplies in the transportation system was one of the most frequent complaints registered during the Vietnam era. The Joint Logistics Review Board (JLRB) report emphasized the need for control mechanisms in the theaters of operation.[2] Specific problem areas were: lack of advance information on shipments; lack of proper address markings; improper documentation of cargo; unclear description of material; and compliance with Military Standard Requisitioning and Issue Procedures (MILSTRIP) and Military Standard Transportation and Movement Procedures (MILSTAMP).

A task force of the Logistics Systems Policy Committee grouped the continuing problems with movement-control systems into two categories:

● Management systems problems wherein the fault lies in the failure of the system to be responsive and to interface suitably with its various elements.

● Data requirements problems wherein the failure is in the lack of information when it is needed, where it is needed, or in what detail it is needed.[3]

Automation of movement-management in the Defense Transportation System has been in progress for some time.[4] From 1958 to 1962, the Graduate School of Business of Stanford University published a series of three studies examining the

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[1] Weapons Systems Evaluation Group (WSEG), Report 175, *Worldwide Cargo Transportation Management*, Arlington, VA: Institute for Defense Analysis Systems Evaluation Division, (November 1971).

[2] US Department of Defense, "Logistic Support in the Vietnam Era," *Transportation and Movement Control*, Monograph 18. Washington, DC: Joint Logistics Review Board (undated, p. 155).

[3] US Department of Army, *LOGPLAN Profile Report*, Volume II, Tab 1, Washington, DC: Task Group 1-70 of the Logistics Systems Policy Committee (undated, pp. 1-28).

[4] US Army Logistic Center, The Army in the Field Container System Study, Vol IV, "The Effect of Containers on the Transportation Systems," Fort Lee, VA (September 1974).

transportation system and recommended an improved, automated system for overseas theaters. The US Army Transportation School conducted similar studies and in 1962 issued a final report for an improved transportation-movement system overseas. In 1963, MILSTAMP established the basic data elements and input/output formats for an automated system and described in general terms the procedures to be followed in the movement of material.[5] TASTA (The Administrative Support Theater Army, 1965-70) provided the first approved doctrine for automating movements. A functional area description (FAD) for an automated, movement-management system was prepared in 1955 by the US Army Combat Developments Command (CDC) Transportation Agency. The FAD provided the basic input for a transportation, all-mode, movement-management system (TRAMMS) feasibility and system description study contracted to the URS Systems Corporation in 1967 as part of the combat services and support systems program (CS3). After contract completion and approval by DA in December 1969, further effort on TRAMMS was suspended in February 1970 pending clarification of theater organizational structures and proposed changes in logistical concepts and doctrine.

DA efforts to automate movement-management were resumed in August 1972 with the formation of the Terminal Operations and Movement-Management System working group.[6] TOMMS was charged with the development of the overall requirements for a worldwide, multicommand, standard system. These were published in the "TOMMS Baseline Document" in October 1972 and were approved by DA. The Integrated Transportation Management Information Systems (ITMIS) coordinating committee, charged with selecting a single area against which resources could be applied most effectively in an incremental approach toward achieving the military transportation management objectives, recommended that overseas port operations be the first application developed. This was based on the promise of early completion and significant dollar savings that could be realized. The TOMMS working group surveyed port operations in Europe and the Pacific during February and March of 1973 and recommended that the US Army Pacific (USARPAC) system, with modifications, be adopted as the baseline standard port system (SPS). A task force was formed in December 1973 by DA directive to develop the necessary changes and modifications. The baseline system was installed at the BENELUX Army Terminal at Rotterdam in April 1974 and at the Bremerhaven Terminal in June. After succesful testing at Bremerhaven, the system was retrofitted to the USARPAC ports of Yokohama, Naha, and Pursan in July 1974.

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[5] US Department of Defense, DOD Regulation 4500.32-R, *Military Standard Transportation and Movement Procedures*, Washington, DC: US Government Printing Office (1 August 1971).

[6] US Army Computer Systems Command, Department of Army Standard Port System Fact Sheet, Fort Belvoir, VA (December 1976).

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In the interim, movements-management automation development was continuing at the local level.[7] [8] SEAMIST (Seavan Manifest Information System), originated and developed by the Transportation Command, US Army Europe (USAREUR), was implemented in July 1972. SEAMIST was developed to manage and monitor the movement of approximately 4000 containers per month transporting DoD-sponsored cargo in Germany and the BENELUX (Belgium/Netherlands/Luxembourg) countries. In December 1974, SEAMIST was recommended for inclusion in TOMMS as a standard Army system. This recommendation was subsequently approved by the Office of the Deputy Chief of Staff for Logistics (DCSLOG). The Highway Fleet Management System was also implemented at about the same time for use by the 37th Transportation Group, USAREUR. HFM provides the basic data-processing capabilities required to manage a military fleet operation.

Current efforts are directed toward developing and implementing a standard, movement-management system to support overseas theaters.[9] In November 1974, a DA study team identified six basic USAREUR applications and recommended that they be used as a baseline to develop an integrated, movement-management system. Development approval was granted by DCSLOG on 30 May 1975. The objectives of the movement-management system development efforts are:

● Assist the movements manager by collecting, storing, compiling, and analyzing operations data that will provide the complete range of transportation operations and management information.

● Reduce time-consuming and redundant data collection and manipulation by practical employment of automatic data-processing (ADP) procedures.

● Develop and employ standard procedures for transportation planning and operations evaluation.

● Design to allow on-line processing and inquiry and to operate viably in both wartime and peacetime environments.

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[7] CPT A. R. Keltz, Fact Sheet, *Seavan Management Information System (SEAMIST)*, Oberusel, Germany: 4th Transportation Brigade; US Army, Europe (28 October 1975).

[8] MAJ John F. Morris, *Managing Materiel Movements*, Army Logistician: US Army Logistic Management Center, Fort Lee, VA (November-December 1973).

[9] US Department of Army, Office of the Adjutant General, letter, subject: *Terminal Operations and Movement-Management System (TOMMS) Implementation of Movement-Management System (MMS)*, Washington, DC (17 August 1977).

Development to meet these objectives is presently being accomplished in a phased program by the 4th Transportation Brigade, USAREUR, under the conceptual DAMMS Systems shown in Figure 1. Stage I is the continued development of the VIC Program to implement the cargo module. SEAMIST, previously developed, will be incorporated with VIC during Stage I-Phase A to complete the cargo module. The HFM system along with the Passenger Reservation System (PRS), Cargo Traffic Analysis (CTA), Transportation Performance Analysis (TPA), and the Table Maintenance and Retrieval System (TMARS) will be adopted during Stage II to form the remaining four modules. HFM corresponds to the mode module; the others overlap to some extent. Stage III will develop and implement the conceptual DAMMS system as a standard, DA, movement-management system in accordance with AR 18-1.

General guidance for the design, development, and implementation of DAMMS is as follows:

● The system must be capable of providing maximum, essential wartime data requirements while maintaining the flexibility for expansion to the detailed data required in a peacetime environment.

● The system is to provide maximum, functional standardization without regard to geographical distinctions and organizational structures.

● Plug-in/plug-out modules may be utilized as required.

● Subsystems within the total system may be automated or manual. The criteria for automation will be based upon the functional needs at a particular management level rather than the availability of automatic data-processing equipment.

● Maximum use will be made of the best features of systems ongoing or under development.

● Consideration should be given to commercial, off-the-shelf software applications where applicable.

The Department of Army Standard Port System, the other half of TOMMS, is currently scheduled for updating beginning in FY78.

The CCIRS concept was originally published by an ad hoc working group of Army Materiel Command (AMC) in 1970.[10] Captain Crooks, a member of the

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[10] US Army Advanced Materiel Concepts Agency, *Mechanized/Automated Stock Handling in the 1990 Field and Theater Armies*, AHWG 10, Alexandria, VA (April 1970).

SALS

SUPPLY   MAINTENANCE   TRANSPORTATION   SUPPORT
                         ITMIS   SERVICES

AUTOSTRAD   TOMMS

DAMMS   DASPS

CARGO
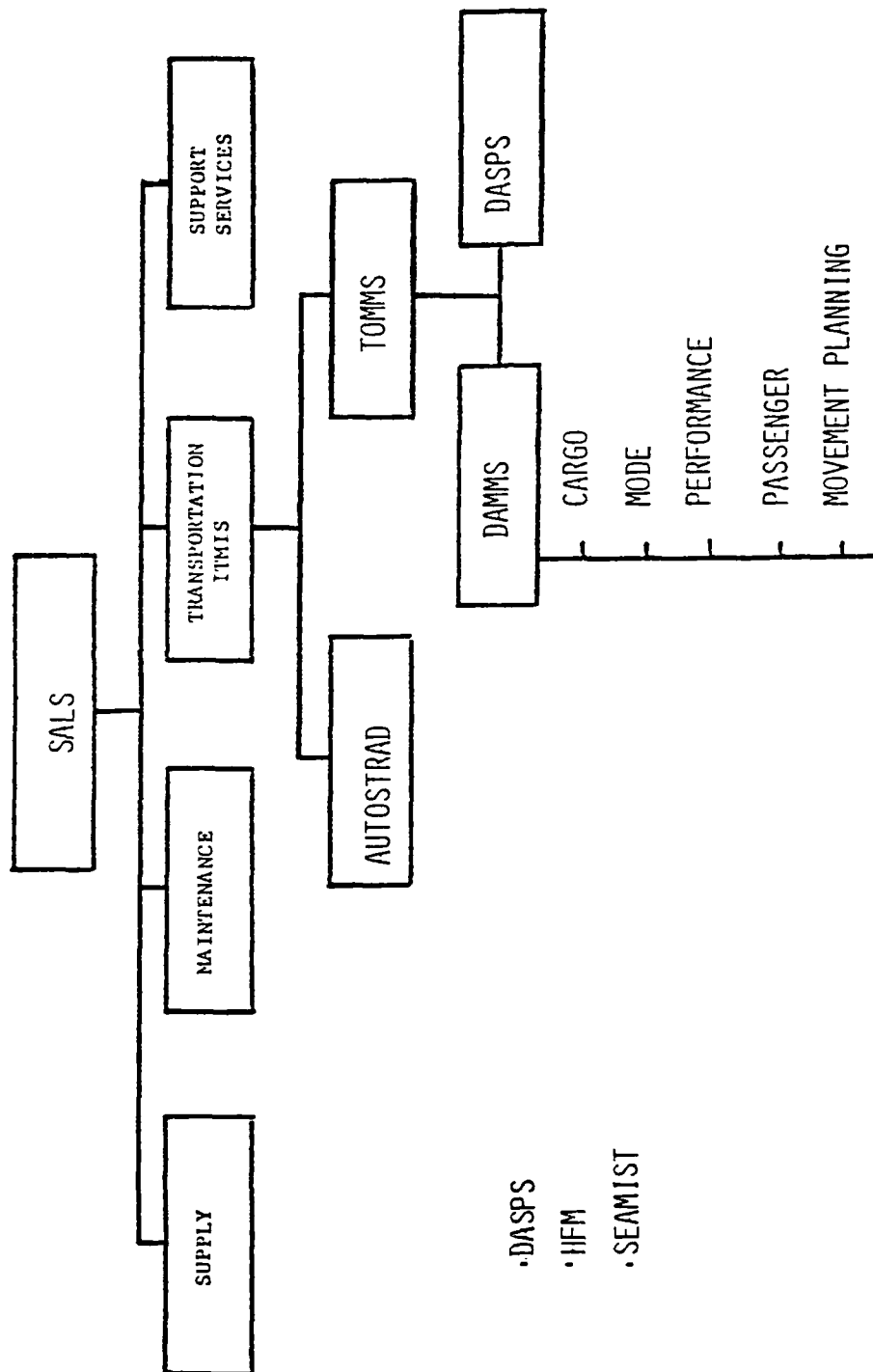MODE
PERFORMANCE
PASSENGER
MOVEMENT PLANNING

• DASPS
• IIFM
• SEAMIST

Figure 1. Standard Army Logistical System (SALS).

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ad hoc working group, subsequently described the concept in detail.[11] CCIRS consisted of an electronic transponder (or label), an interrogator to remotely power and scan the label, and a data buffer to store and forward the label identification number to a central computer facility along with time and location information.

This basic CCIRS concept was included in both the WSEG and LOG CTR studies on cargo movement and control.[12][13]

WSEG treated the Defense Transportation System (DTS) as two distinct but parallel systems: the physical system that the cargo actually moves through, and a software system for the documentation flow. It is considered significant that the lack of automatic data processing was a common factor contributing to major problems in both systems; i.e., lack of timely intransit data complicates expediting, holding, diverting, or cancelling shipments within the physical systems; and the proliferation of manual processing in the software system perpetuates errors in reports and the transmission of data.

The WSEG study concluded that the current procedures for military cargo transportation management were inadequate from the standpoint of exercising effective control over cargo movement, meeting standards of performance, providing needed management information, and planning for contingency operations. The study observed that the ". . . use of an automatic label-reading technique appears to offer the most significant promise for eliminating many of the error problems identified in the present systems . . . ." The recommendation was made that the automatic, label-reading device be pursued as part of an interim program oriented toward current procedures and that development of any advanced system be delayed until such improvements could be accomplished and the results evaluated using the more valid data which could be expected.

In general, WSEG's specific recommendations featured extensive use of automatic data processing coupled with real-time data to solve the numerous problems identified in both the physical and the software system. The LOG CTR study, relative to movement-management procedures, focused on operations within the theater of operations. Based on the large-scale use of containers anticipated in future conflicts and the need for rapid turnaround, the AFCSS (Army in the Field Container System Study) found that modifications were required in these procedures. An advanced.

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[11] Capt. Edgar T. Crooks, *Commodity Oriented Digital Input Label System (CODILS)*, US Army Advanced Materiel Concept Agency Report AMCA-71-008, Alexandria, VA (April 1971).

[12] Weapons Systems Evaluation Group (WSEG); Report 175, *Worldwide Cargo Transportation Management*; Arlington, VA: Institute for Defense Analysis Systems Evaluation Division (November 1971).

[13] US Department of Defense; "Logistic Support in the Vietnam Era," *Transportation and Movement Control*, Monograph 18. Washington, DC: Joint Logistics Review Board (undated, p. 155).

fully automated, movement-management system, including a CCIRS-type, label-reading device for source data automation, was recommended for the 1975-1982 time frame. Specific advantages cited included substantial reduction in documentation error rate, improved capacity for rapid transportation response, reduced manpower requirements, and improved intransit visibility of containers and cargo. In retrospect, this advanced system corresponds to DAMMS, which is currently being developed by the 4th Transportation Brigade, USAREUR. An interim system also was recommended to assist in the transition from manual processing to a fully automated system.

A draft Required Operational Capability (ROC) for the automatic, label-reading device was included in the main report of the AFCSS study. Although the ROC was entitled "ALMICS" after the general functional description of the Automated Logistic Management Inventory Control System, it was limited to source-data automation equipment required to provide real-time data in response to the above problems. The ROC called for three functional modes of employment: line-side, mobile, and gate. The interrogator, placed along the side of a highway to monitor traffic, for example, is referred to as the line-side mode of operation; the physical movement of the interrogator through a marshaling yard is referred to as the mobile mode. These three generic categories are sufficient to cover the typical modes and links encountered in any transportation distribution network.

The ALMICS ROC served as the basic forerunner of the current CCIRS draft requirements documents. The original requirement for a data storage device (Figure 2) has evolved to include a data-processing terminal. Although the local data-processing capability and two-way digital communications provided by a mini-computer center might be extremely beneficial in terms of a local command and control function, they are not required to meet the basic-source, data-automation function originally intended in the ALMICS concept. The dash line in Figure 2 illustrates the alternate modes of communication in which the current CCIRS concept is capable of operating. A detailed discussion of CCIRS is presented in Section II.

The DCSLOG Phase II Study, although on a much broader scale, endorses the underlying reasons for automated, movement-management systems in their Logistic Concept for "Total Systems Management" at the Theater Army level. This concept is to provide intensive management for selected classes of supply and weapon systems including their movement and distribution. One of the functions of the systems manager is to call forward preplanned supplies and arrange for their distribution. The rationale for this function rests on the expectation that large tonnages and thousands of lines of materiel will accumulate unless they are called forward rather than being pushed. This is based upon experience, especially in Vietnam, where pushed packages created globs of gray boxes in which the U.S. did not know what we had,
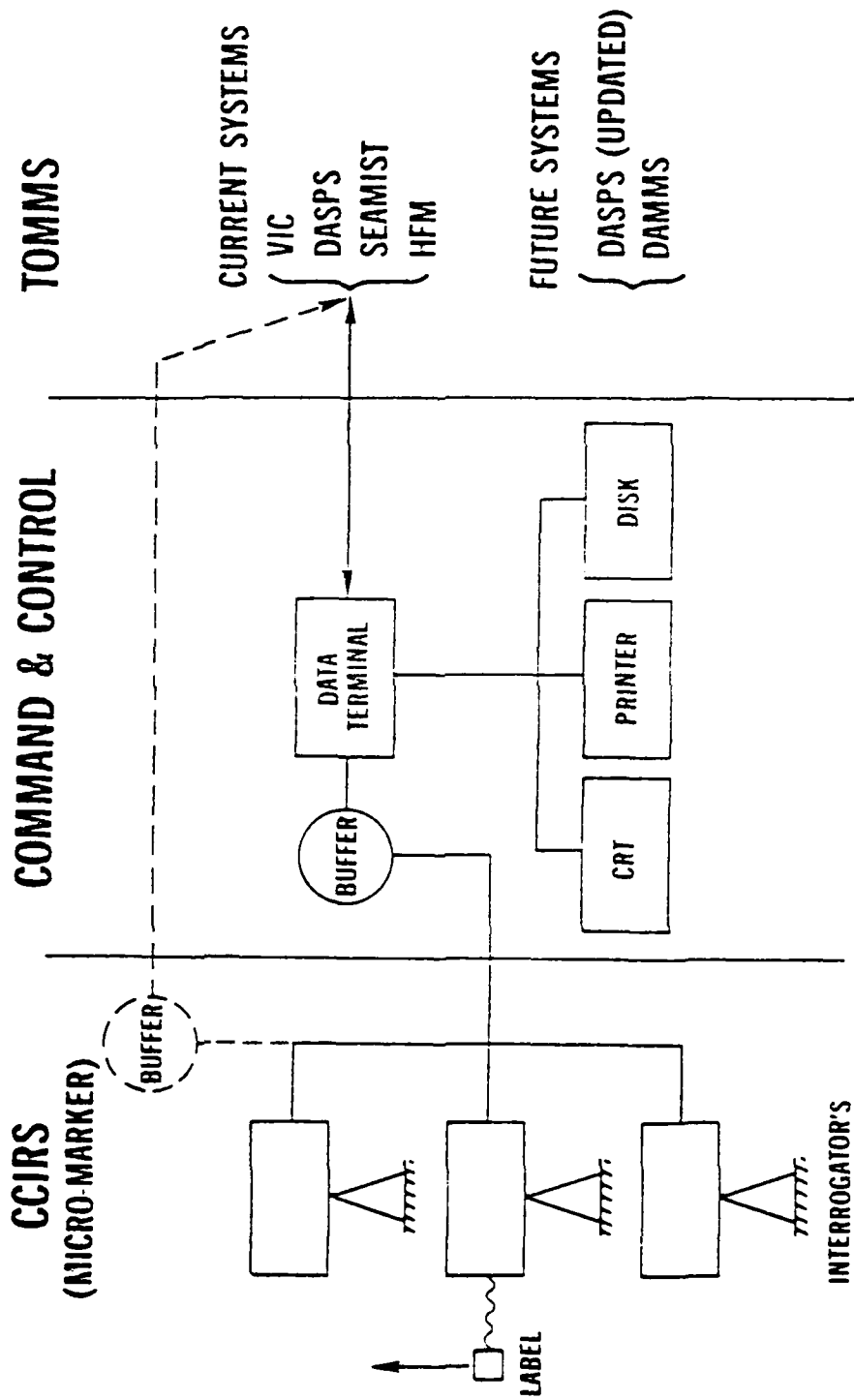
Figure 2. Functional concept.

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who needed it, nor the force structure required to move it. The DCSLOG Phase II study also makes the major point that if a function is provided in peacetime, it must also be provided in wartime. This appears to be directly applicable to the movement-management function of the theater level Movement Control Center and its interface with the host-country transportation system. Automated data processing coupled with source-data automation may prove essential in obtaining the necessary container turnaround times within the theater of operations required to support materiel tonnages projected for future conflicts.

In summary, the source-data automation concept originally published by The Advanced Materiel Concept Agency (AMCA) in 1970 was incorporated in both the WSEG and the Logistic Center's AFCSS study as the central building blocks by which major improvements could be provided in logistic-management procedures. These improvements relied upon source-data automation and automatic data-processing techniques to provide timely intransit data necessary to support the movement-management functions of expediting, holding, directing, and cancelling of shipments as well as the elimination of repetitive documentation. Hardware development and testing of the source-data automation concept was initiated at MERADCOM under tasking received from Project Manager – Army Container-Oriented Distribution System (PM-ACODS) in March 1972. Concurrent with this development through the 1978 time frame, interim systems were developed in the overseas theater, thus providing the software systems required to use real-time data effectively. Under current DA policy as expressed in the Adjutant General's letter of 17 August 1977 regarding the implementation of TOMMS, these systems will be implemented world-wide as a DA standard movement-management system.

The chronology leading to this goal extends over a time period of some 20 years going back to the initial Stanford studies in 1958. This is an appreciable span of time, in which many people have come and gone, to have maintained a program with essentially the same basic goal of providing an automated logistic-management system. The basic need must have been strong, indeed, to have survived this test of time. The Vietnam experience as cited in the DCSLOG Phase II Study and as documented by the monographs of the Joint Logistic Review Board has undoubtedly played a significant role in maintaining visibility for the need of an effective movement-management system.

II. DESCRIPTION OF EQUIPMENT

5. **Hardware.** CCIRS hardware consists of labels, interrogators, and data terminals. The labels are attached to cargo containers, trucks, and like assets and positioned to monitor the flow of assets as desired. Each of the interrogators is linked to the data terminal by dedicated telephone lines.

a. **Labels.** CCIRS labels are microwave transponders which are passive until activated by an interrogator. When activated, the label transmits a serial number which is used to identify the asset to which it has been attached (Figure 3).

Most labels fabricated to date consist of a microwave section and a digital section assembled into a 4- by 5- by ½-inch aluminum housing and is potted in place. The microwave section is a sandwich of metal-clad plastic plates etched for form strip-line antennas and filters. The digital section is a conventional, printed circuit board populated with separately packaged integrated circuits. A limited number of advanced models only ¼-inch thick have been fabricated. These advanced models incorporate a hybrid packaging technique and eliminate the printed circuit.

Label operation is initiated by sufficient, incident microwave energy from an interrogator to actuate the digital section. As depicted in Figure 4, microwave energy is received by an antenna assembly, rectified, filtered, and regulated to provide a d.c. voltage to operate the digital section. The digital section's control elements cause the label's data to be sent as a coded pulse stream to a second antenna assembly in the microwave section. There, the pulse stream is introduced into a turned circuit attached to the second antenna assembly. The turned circuit is designed to cause a generous reradiation of the second harmonic of the incident microwaves but is arranged to be detuned with the pulse stream. Thus, a modulated signal containing the label's data is generated for reception by the interrogator. The interrogator provides all energy required for the label's operation.

The label data conform to International Standardization Organization (ISO) standards for container identification. The data consist of four alphabetic characters comprising an ownership code, a 6-digit serial number, and a check digit. The data are programmed unto a diode-array storage element in the digital section. In general, however, the labels can be field-programmed. These factors are of extreme importance in the general use of commercial containers for Military transport. The ISO serial number provides a common element with commercial practice since this number is used exclusively by commercial shippers in their data-processing systems for control and identification of their assets. The number will be present in the same location on every commercial container delivered for Military use. Field programability will allow "blank" labels to be stockpiled and applied rapidly to containers when needed.

b. **Interrogators.** As the label moves into the CCIRS interrogator's field of view, the interrogator reads the label's code and serial number and transmits the label information to a central data terminal. The interrogators are positioned at key points along the routes taken by trucks and containers; thus, the identity of the passing assets becomes available to the central location as the movement is taking place (Figure 5).

11
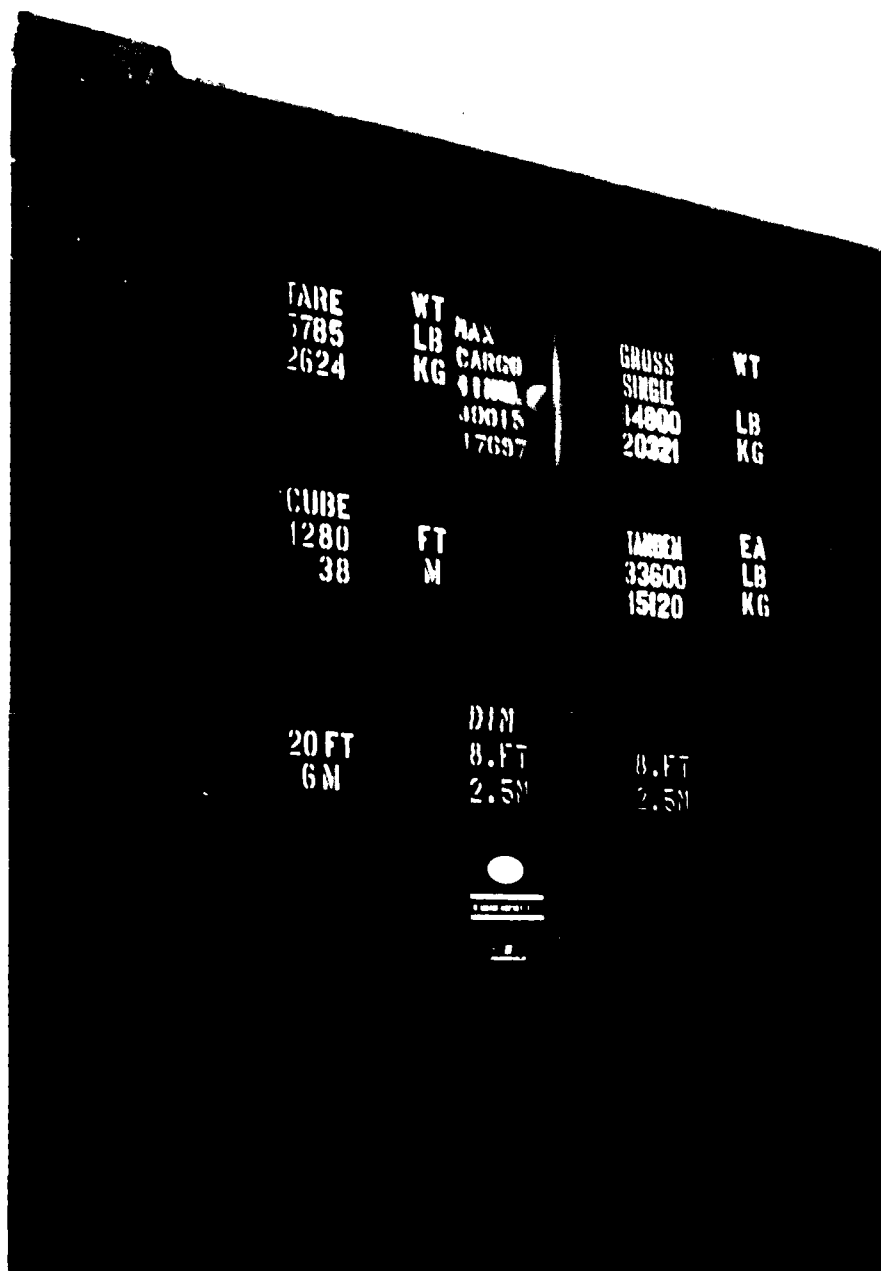
Figure 3. CCIRS label.

12
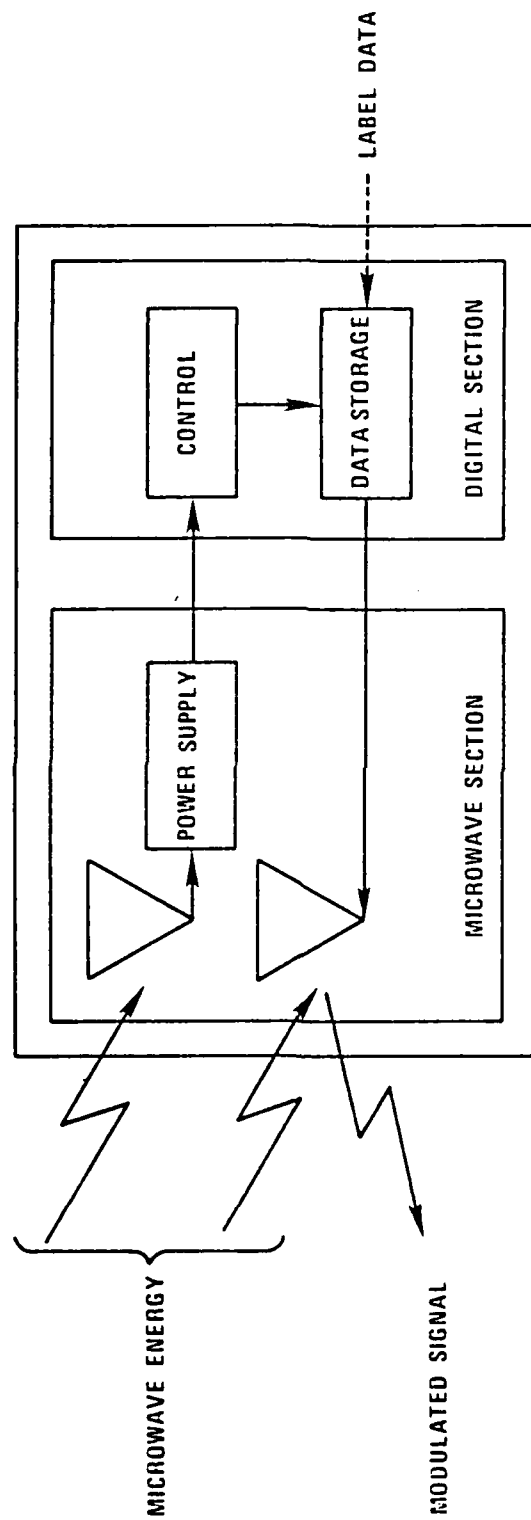
Figure 4. Schematic of label.

13

Figure 5. CCIRS interrogator.

14

Positioning of the interrogator at key points is to some extent restricted by its zone of interrogation. For operational purposes, this zone can be thought of as extending from 4 to 20 feet from the face of the interrogator and from the top of the trailer or chassis wheels to half way up the side of the container. This allows the use of this type of interrogator on all standard two-lane roads. Additional design work has indicated that changes of from 40 to 80 feet are possible.

Interrogators incorporate an inclosed antenna assembly with transmit and receive arrays composed of horizontally arranged slots machined in rectangular wave guides. The antenna assemblies are attached to electronics packages. Internally, these are composed of modular microwave inclosures for the transmitter and receiver; printed circuit cards in a guide assembly for the signal processor, data processor, and modem; and power supplies which are the heaviest components in the interrogator (Figure 6).

The interrogator normally operates in a search mode transmitting a relatively low level of microwave energy for label detection. When a label enters the antennas's field of view, its presence is detected by reception of the second harmonic reflected from the label. At this point, the energy transmission is increased to power the label. This interrogate mode continues until a read has been validated, a false alarm has been determined, or a time default has occurred. A read is validated when two identical bit streams have been received from the label. False alarms are identified by the absence of pulses in the second harmonic. The read attempt is defaulted when sufficient time has elapsed for the label to send its data three times. Whenever a validated read occurs, the label data are forwarded through the modem to a dedicated telephone line.

c.   **Data Terminal.** The CCIRS data terminal receives label data from the interrogators. The channel on which the data arrive from an interrogator determines the location of the asset. The identity, location, and time (supplied by the data terminal) are now available for logical manipulation, storage, and output by the data terminal (Figure 7).

The data terminal equipment used with the developmental hardware consists of a commercial minicomputer system mounted in a 19-inch electronics rack with free-standing and desk-top peripherals (Figure 8). The rack-mounted equipment includes the minicomputer with 8K (8192 16-bit words) of core memory; a dual "floppy" disk unit with a capacity of 256K (256, 256 8-bit) bytes per drive; three 2400-baud modems; a paper-tape reader/punch (punch capacity 50 characters per second); dual cassette magnetic tape drive; an extension box with 12K (12,288 16-bit words) of supplemental semiconductor memory; and the interfaces required for the peripherals. Free-standing equipment includes a 180-character-per-second
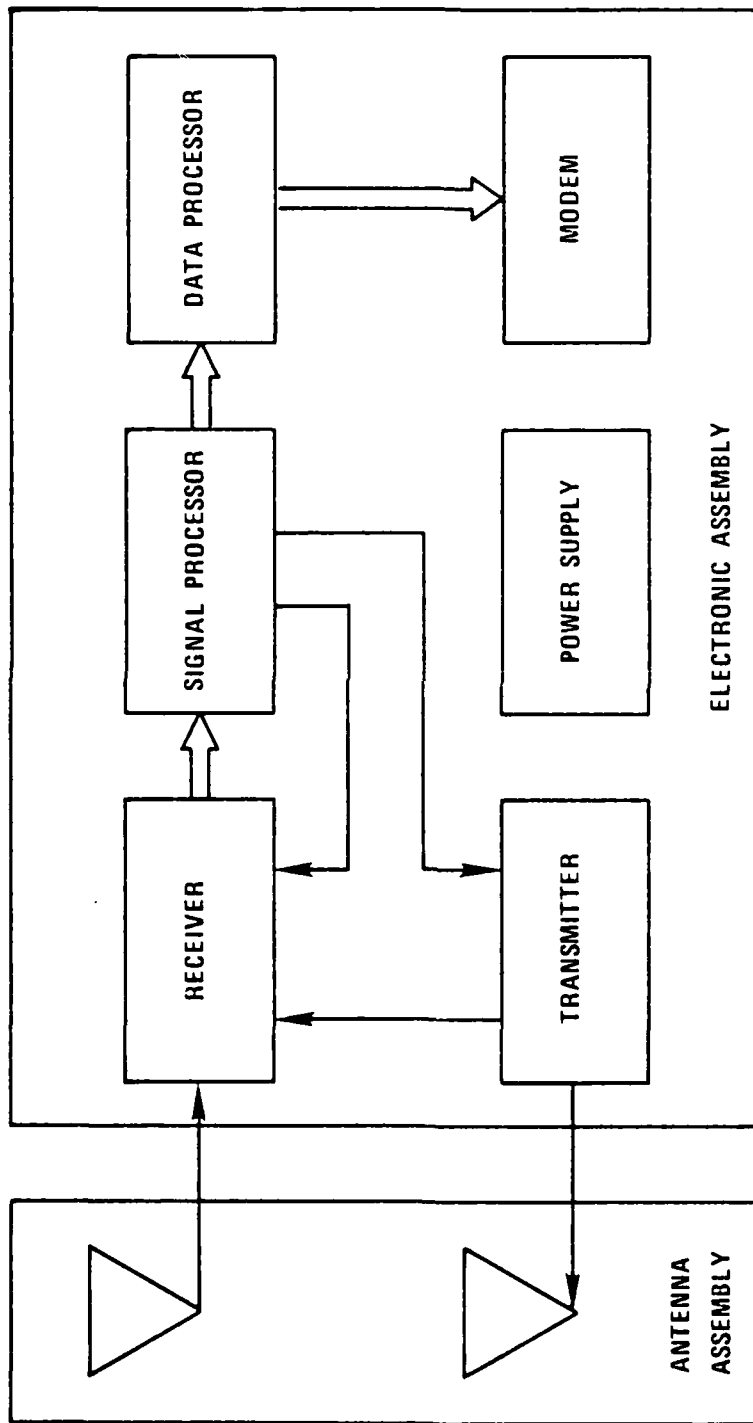
Figure 6. Schematic of interrogator.

16
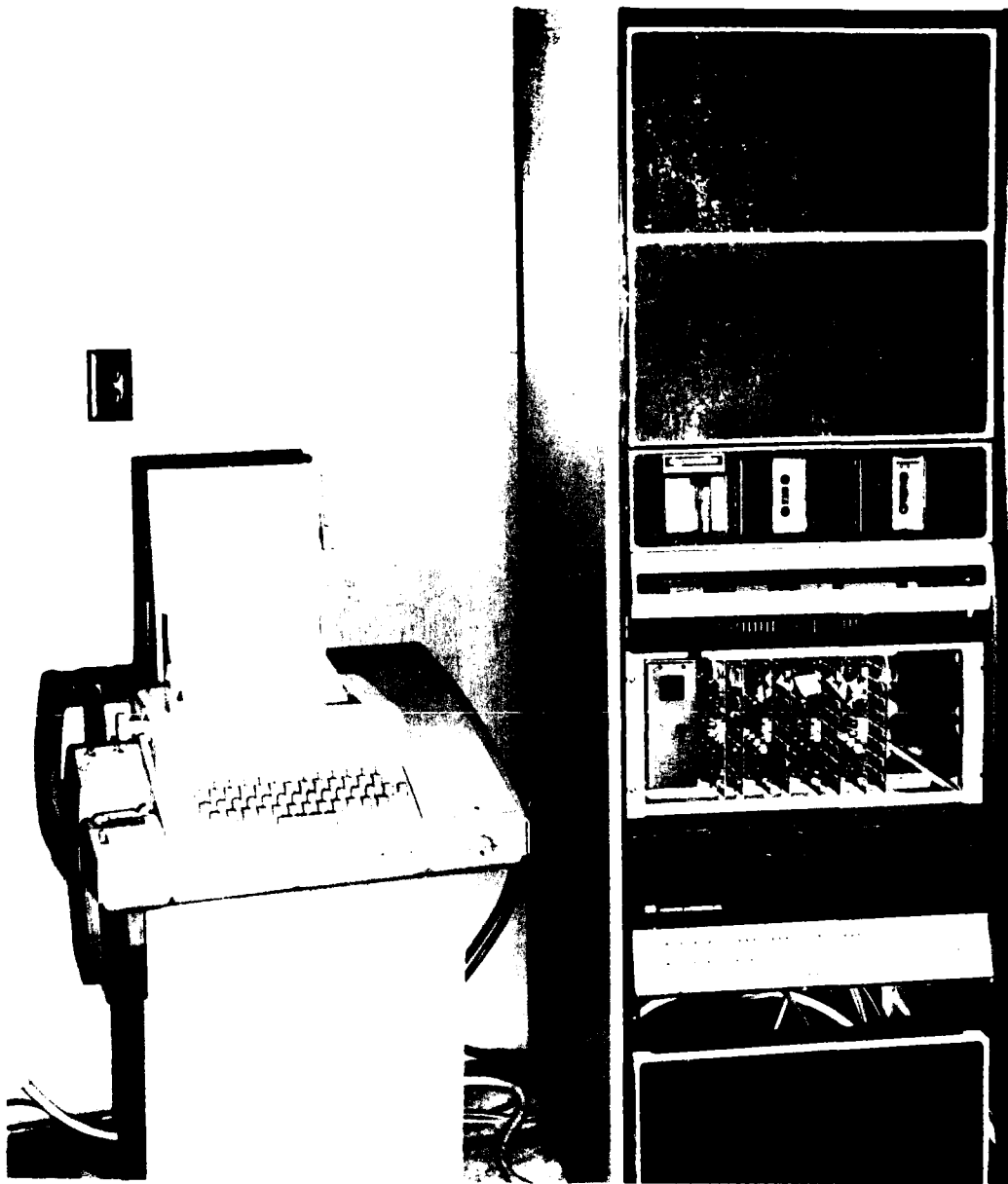
Figure 7. CCIRS data terminal equipment.

Figure 8. Schematic of CCIRS data terminal equipment.

printer and a 10-character-per-second ASR-33 teletypewriter. Desk-top equipment consists of a 285-card-per-minute, punched-card reader and a cathode ray tube (CRT) terminal. It should be noted that the teletypewriter and the CRT terminal perform equivalent functions but cannot be used simultaneously.

During routine operation, data arrive at the data terminal from the interrogators through the modems. The modems forward data to the minicomputer's processing unit via the bus. The processor uses the memory to buffer the data, attach date and time, and make other logical associations before updating records on the disk unit and making a monitoring output to whichever terminal is online. Data records on the disk unit are created and can be modified by input from the card reader. The cards were normally received from the Standard Port System Remote Process Facility (RPF). Output based on the disk data records is made in a report form via the printer or in media suitable for AUTODIN transmission on the paper-tape punch. The cassette tape unit is used only for offline storage of data and programs.

6. **Software.** The functioning of the data terminal is controlled by mini-computer programs written for the desired function. The execution of the programs is controlled by a system monitor and supported by utility subroutines and programs. As in most computer systems, the monitor and utilities are supplied by the hardware manufacturer to simplify use of the equipment.

The software system allows three priorities of processing to take place: interrupt handling, foreground processing, and background programs. Although these three levels of processing are scheduled to take place in accordance with their priorities, the speed at which the computer performs the processes allows them to be thought of as being executed simultaneously. Each of the levels is processed independently; therefore, two interface buffers are required to establish communication. The first buffer is the input queue which links the interrupt handlers to the fore-ground processing. The second buffer is the data files which hold the results of fore-ground processing for one of the background programs (Figure 9).

a. **Interrupt Handling.** Interrupt handling is the highest priority level of processing. Whatever processing is taking place when data arrive in a modem is interrupted by hardware incorporated in the minicomputer. The data element present at the modem interface when an interrupt occurs is a character. This character is subjected to several validity checks and moved to a buffer where it is held until all the characters of a particular label have arrived. After each character has arrived, the processing in progress at the time of the interrupt is resumed. After the last
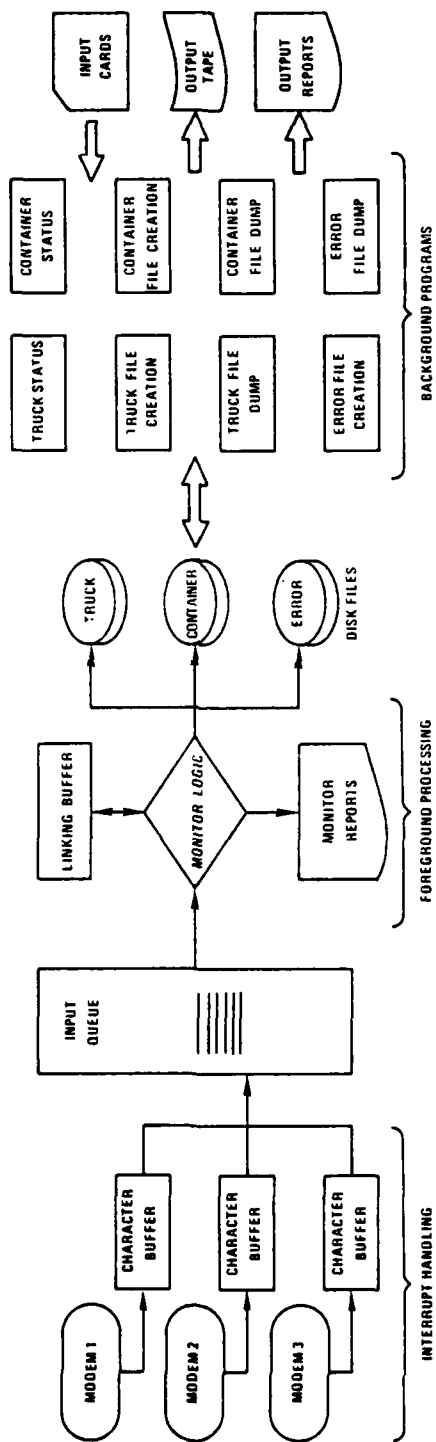
Figure 9. CCIRS data terminal processing.

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character in a label has arrived, the entire label data are moved to the point queue for foreground processing. Since the time required for character and label data movement is short compared to the time it takes for a full character to arrive at the modem, foreground processing or whatever background program may be in progress can continue with little retardation due to interrupt handling.

b. **Foreground Processing.** Foreground processing is the second highest priority level. This processing searches the input queue for label data, identifies the label as a particular truck or container, links truck and container labels which arrive consecutively on the same channel within 20 seconds, links the current time and date with the truck/container pair, and updates the data files accordingly. In addition, based on coding in the data files, an appropriate message is selected and a descriptive output is sent to the terminal (Figure 10). The purpose of the descriptive output is to verify correct system operation and to give the operation for ongoing operations. This output can be suppressed by keyboard comments. When the foreground processing finds no label data in the input queue, it yields processing time to any background program which may be in progress.

The most important function of foreground processing, however, is the updating of the data file structure. This file structure contains three data files: a truck file, a container file, and an error file. Both the truck file and the container file contain item records which can be accessed directly based on the label number. The third data file, the error file, contains all interrogator inputs which could not be identified as a truck or a container. Typically, the data accumulated in this file consist of labels which are not in the truck or container files or data which have become garbled in transmissions.

c. **Background Programs.** Since background programs normally involve outputting data from the files to the printer or the paper-tape punch through the buffer arrangement similar to input interrupt handling, operation is effectively interlevel. The data terminal appears to be simultaneously outputting a message on the teletype, listing a report on the printer, and accepting data from interrogators.

A background program could be written to interface the disk files to a standard data communication system making it possible to provide a fully automated interface with Standard Army Management Systems.

III. OVERALL FRAMEWORK IN WHICH EQUIPMENT MUST OPERATE

7. **Cargo Flow in the Defense Transportation System.** The Defense Transportation System is responsible for transporting cargo from the CONUS to the theater of operations. The movement of this cargo in as nearly a straight line as possible with

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@ 2043 TRUCK 19MC365435 DEP TERM FOR BEACH    WITH CONTAINER 04131
@ 2051 TRUCK 19MC371755 ARR AREA FROM BEACH   EMPTY
@ 2101 TRUCK 19MC365316 ARR AREA FROM BEACH   EMPTY
@ 2104 TRUCK 19MC365448 ARR AREA FROM BEACH   EMPTY
@ 2115 TRUCK 19MC365366 DEP TERM FOR BEACH    WITH CONTAINER 04851
@ 2116 TRUCK 19MC365316 DEP TERM FOR BEACH    WITH CONTAINER 06522
@ 2117 TRUCK 19MC365440 ARR AREA FROM BEACH   EMPTY
@ 2118 TRUCK 19MC371755 DEP TERM FOR BEACH    EMPTY ✓
@ 2120 TRUCK 19MC365440 DEP TERM FOR BEACH    EMPTY
@ 2121 TRUCK 19MC365300 ARR AREA FROM BEACH   EMPTY
@ 2123 TRUCK 19MC365447 DEP TERM FOR BEACH    WITH CONTAINER 03889
@ 2124 TRUCK 19MC365358 ARR AREA FROM BEACH   EMPTY
@ 2126 TRUCK 19MC365448 DEP TERM FOR BEACH    EMPTY ✓
@ 2130 TRUCK 19MC365445 DEP TERM FOR BEACH    EMPTY ✓
@ 2134 TRUCK 19MC365300 DEP TERM FOR BEACH    WITH CONTAINER 07002  ◆
@ 2140 TRUCK 19MC365440 ARR AREA FROM BEACH   EMPTY
@ 2143 TRUCK 19MC365435 ARR AREA FROM BEACH   EMPTY
@ 2148 TRUCK 19MC365440 DEP TERM FOR BEACH    WITH CONTAINER 04398
@ 2149 TRUCK 19MC365316 ARR AREA FROM BEACH   EMPTY
@ 2151 TRUCK 19MC365435 DEP TERM FOR BEACH    WITH CONTAINER 09745
@ 2156 TRUCK 19MC365448 ARR AREA FROM BEACH   EMPTY
@ 2201 TRUCK 19MC365300 ARR AREA FROM BEACH   EMPTY
@ 2205 TRUCK 19MC365316 DEP TERM FOR BEACH    WITH CONTAINER 04304
@ 2208 TRUCK 19MC365440 ARR AREA FROM BEACH   EMPTY
@ 2209 TRUCK 19MC365300 DEP TERM FOR BEACH    WITH CONTAINER 04451  ○
@ 2210 TRUCK 19MC365448 DEP TERM FOR BEACH    WITH CONTAINER 04833
@ 2210 TRUCK 19MC365358 DEP TERM FOR BEACH    EMPTY
@ 2215 TRUCK 19MC365440 DEP TERM FOR BEACH    WITH CONTAINER 06678
@ 2224 TRUCK 19MC371726 ARR AREA FROM BEACH   EMPTY
@ 2226 TRUCK 19MC371720 ARR AREA FROM BEACH   EMPTY
@ 2228 TRUCK 19MC365435 DEP TERM FOR BEACH    WITH CONTAINER 03953
@ 2228 ERROR ON CHANNEL   2 = 1@SAC007458
@ 2228 TRUCK 19MC365300 ARR AREA FROM BEACH   EMPTY
@ 2232 TRUCK 19MC365366 ARR AREA FROM BEACH   EMPTY
@ 2235 TRUCK 19MC365316 ARR AREA FROM BEACH   EMPTY
@ 2236 TRUCK 19MC371726 DEP TERM FOR BEACH    WITH CONTAINER 04110  ■
@ 2237 TRUCK 19MC365300 DEP TERM FOR BEACH    WITH CONTAINER 04853  ★
@ 2238 TRUCK 19MC371755 ARR AREA FROM BEACH   EMPTY
@ 2241 TRUCK 19MC371720 DEP TERM FOR BEACH    WITH CONTAINER 03682
@ 2243 TRUCK 19MC365316 DEP TERM FOR BEACH    WITH CONTAINER 07510
@ 2246 TRUCK 19MC365447 ARR AREA FROM BEACH   EMPTY
@ 2247 TRUCK 19MC365445 ARR AREA FROM BEACH   EMPTY
@ 2250 TRUCK 19MC365366 DEP TERM FOR BEACH    WITH CONTAINER 03805
@ 2255 TRUCK 19MC371755 DEP TERM FOR BEACH    WITH CONTAINER 03791
@ 2253 TRUCK 19MC365440 ARR AREA FROM BEACH   EMPTY
@ 2259 TRUCK 19MC365316 ARR AREA FROM BEACH   EMPTY
@ 2306 TRUCK 19MC365435 ARR AREA FROM BEACH   EMPTY
@ 2307 TRUCK 19MC365300 ARR AREA FROM BEACH   EMPTY
@ 2308 TRUCK 19MC365440 DEP TERM FOR BEACH    EMPTY
@ 2310 TRUCK 19MC365316 DEP TERM FOR BEACH    EMPTY
@ 2310 TRUCK 19MC365447 DEP TERM FOR BEACH    WITH CONTAINER 03831
@ 2312 TRUCK 19MC365445 DEP TERM FOR BEACH    WITH CONTAINER 04271  ▲
```

Figure 10. Example of terminal messages.

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a minimum number of stops is of prime importance to the Department of Army during wartime contingencies. The movement starts with depots in the CONUS accepting and storing materiel from manufacturers for shipments overseas. The amount of materiel stored by the depots is based on operational plans and contingencies. All shipments from the CONUS depots are directed by the national inventory control points (NICP's) and are based on requisitions from units needing supplies.

In the combat zone, requisitions flow from the Division Material Management Center (DMMC) and from nondivisional direct-support (DS) and general-support (GS) units to the Material Management Center (MMC) of the Corps Support Command (Figure 11). If materiel is available, the MMC will direct a GS unit to issue supplies to a DS unit. If not, the requisitions go from the MMC to the appropriate CONUS NICP through the Defense Automatic Addressing System (DAAS). Requests from DS and GS units in the communications zone are sent to the TAACOM MMC and then, in a similar manner to the appropriate CONUS NICP. From there, material-release orders are given to the CONUS depots to ship supplies to the units overseas. Depots process and ship full container and air pallet loads directly to the requisitioning DSU and GSU. Less than full container and air pallet loads are shipped to the container consolidation points for consolidation, containerizing, and shipping to the DSU and GSU.[14]

The Military Airlift Command (MAC) and Military Sealift Command (MSC) provide transportation for the cargo destined to the overseas theater through a combination of organic means and commercial augmentation. It is the responsibility of the Military Traffic Movement Command (MTMC) to control the movement of this cargo from the CONUS to the theater terminals.

Once the materiel is in the theater of operations, MTMC has different duties for each respective command's terminal. For cargo moving by ocean, MTMC controls movement to and through ocean terminals, loads and unloads ships at military terminals, and arranges for terminal services through commercial facilities as required. In the case of air terminals, MTMC's duty is limited to controlling supplies into air terminals; MAC operates the terminals and loads and unloads the aircraft. Various modes of transportation such as air, motor, rail, and water transport are then utilized to distribute the requested supplies to the users.

The Theater Army Movement Control Center performs overall supervision in getting the supplies to the users. MCC, in coordination with the Theater Army MMC, establishes distribution patterns so that the resources of both the GSUs and

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[14] US Department of Army Field Manual FM 54-10, *Logistics — An Overview of the Total System* (April 1977).
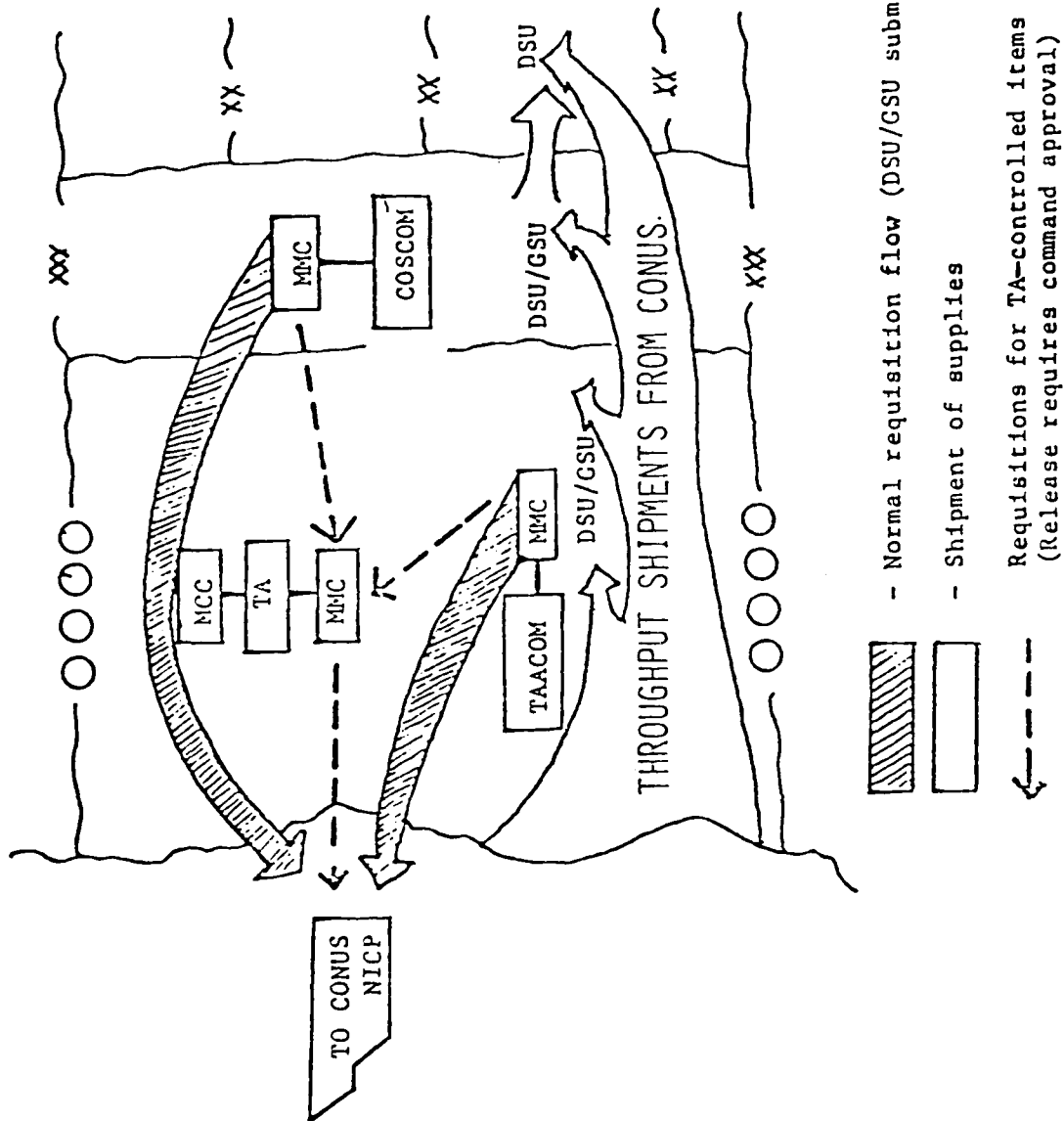
Figure 11. Materiel flow: Theater of Operations.

the transportation system can be utilized best. In determining these distribution patterns, consideration is given to the capabilities of the consigner and consignee to ship and receive by various modes, to their total capabilities, to their respective geographical locations, and to their locations with respect to the available transportation system. Additionally, MMC works in conjunction with COSCOM to facilitate throughput shipment for CONUS, movement within the corps rear area, and shipments going forward to the divisions.

The actual transporting of the requested supplies is provided by different transportation units within each level of the theater. At Theater Army level, the 4th Transportation Brigade in Europe provides theaterwide transportation service and is the principal Army transportation headquarters in the theater. At corps level, transportation units are assigned to provide mode operations depending on the requirements. At division level, a transportation motor transport company is assigned to the supply and transport battalion of the division support command. This company provides the minimum capability for moving general cargo and is sometimes augmented by water transport from the COSCOM.

8. **Organization and Mission of Transportation Support Units in a Theater of Operations.**

a. **Theater of Operations.** The theater of operations is normally divided into a combat zone and a communications zone (COMMZ) (Figure 12). The theater commander retains overall control of combat service support operations to insure uniformity of support in the combat zone and COMMZ. A COMMZ is established when it is impractical for the tactical commander to control the theater base of operation. The COMMZ encompasses the rear area containing the lines of communications established for supply and evacuation and the organizations required for immediate support and maintenance of the field forces. The combat zone is that part of the theater that the combat forces require to conduct operations. It extends forward from the communications zones to the area controlled by the enemy. The combat zone is divided into corps areas and division areas, each including its own service areas.

b. **Structure of the Theater Army.**[15] The organization of the Theater Army (shown in Figure 12) includes four major functional commands (PERSCOM, EMCOM, TRANSCOM, MEDCOM) and an area command (TAACOM) in the communications zone. In addition, it contains a Theater Communication Command (Army), an Air Defense Brigade, and other major units that are assigned or attached.

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[15] US Department of Army Field Manual 54-7, *Transportation Logistics* (November 1976).

25
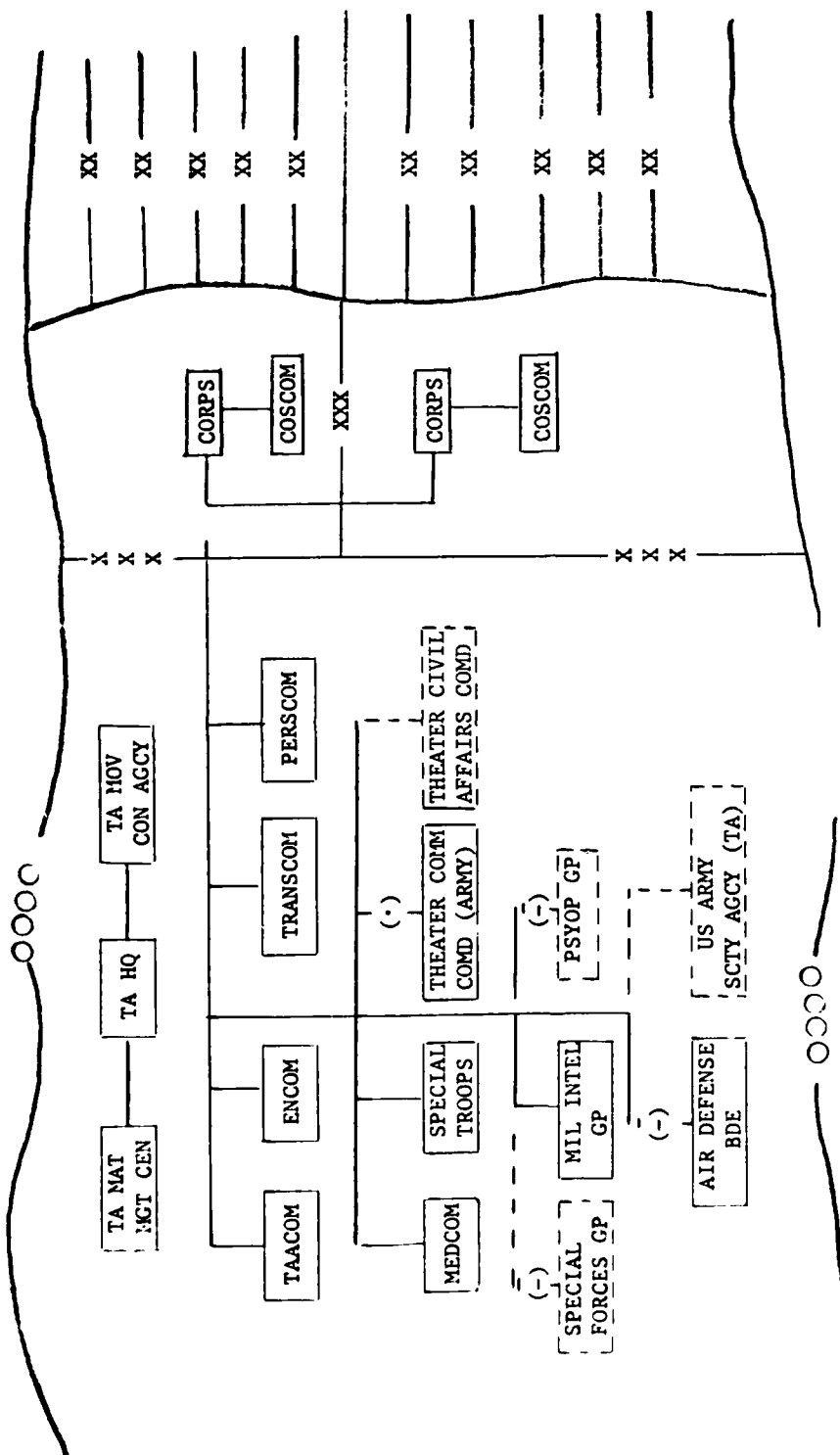
Figure 12. Organization of Theater Army.

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The functional and area commands provide combat service support to Army forces and other agencies as directed. This includes direct and general support in the communications zone, rear area protection, and general support to forces in the combat zone. The TAACOM performs a variety of direct-support, combat-service functions, provides general-support supply and maintenance, and services the functional commands to units located in or passing through the COMMZ.

c. **Transportation Command.**[16]

(1) **Organization.** The organization of TRANSCOM (Figure 13) consists of a Headquarters and Headquarters Company (HHC) and subordinate units such as Terminal Transfer Company, Motor Transport Group, Aviation Battalion, Terminal Group, and Railway Group.

[16] US Department of Army Field Manual, *Transportation Logistics* (November 1976).
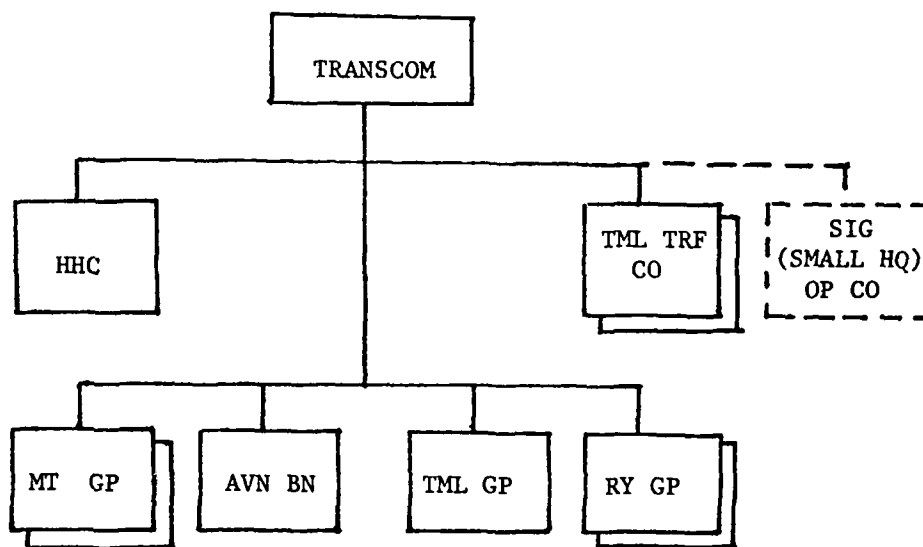
Figure 13. Organization of TRANSCOM.

The missions of TRANSCOM Headquarters are:

● Commands and controls assigned and attached units.

● Supervises the operations of the transportation interzonal services.

● Advises on transportation services in the theater.

● Recommends transportation policies.

● Recommends the allocation of transportation resources.

● Maintains liaison on transportation operation with Theater Army, TAACOM, Corps, and COSCOM headquarters; other services; allied and host-nation staffs, and transportation mode and terminal facility operations.

(2) **Operations.** The TRANSCOM operates under the general staff supervision of the TA AC of S Transportation. When authorized and directed by the TA Commander, the TRANSCOM Commander may represent TA as follows:

● Participate in the joint transportation board (JTB).

● Perform liaison with host and allied nations to include negotiation for procurement of transportation facilities or establishment of operating agreements and establishment of policies and procedures with allied nations for mutual transportation support.

The HHC, TRANSCOM, commands and controls its subordinate units which provide terminal services and operate the transport mode.

Transportation services to place men and materiel where and when needed are planned and coordinated from their origin in CONUS to their final destination in the theater. After replacements and materiel arrive in the theater, the TRANSCOM is responsible for continuing their movement to designated destinations. The TRANSCOM includes all elements necessary to move personnel and materiel from points of arrival in the theater to general-support, direct-support, and user units. The TRANSCOM performs this service for the Army and, as required, for other US forces, host nations, or allied forces. Based on shipping instructions, the TRANSCOM provides the transport necessary for movement of supplies.

Transport (mode) operations in the theater include air, motor, rail, and inland waterway. Most transport operations are interzonal (theaterwide) services that the TRANSCOM centrally control in coordination with the TA MCC; the remainder are movements within the COMMZ. Military Airlift Command units provide interzonal airlift. Army air transport units provide airlift support for Army forces in accordance with operational requirements.

Subordinate to the transportation command are transportation mode and terminal brigades, groups, and battalions.[17] Battalion headquarters units are authorized on the basis of 3 to 7 subordinate transport or terminal operating companies. Transportation group headquarters are authorized for command and control of 2 to 7 transportation battalions. In turn, transportation brigade headquarters are normally allocated on the basis of three or more subordinate groups. Special situations such as magnitude of the land area or operating conditions may require a brigade headquarters to command only two group headquarters. In the present organization of Theater Army Europe, the TRANSCOM has been replaced by the 4th Transportation Brigade.

d. **Transportation Movement Control Agency.**[18] The Transportation Movement Control Agency (MCA) is a subordinate unit of the Theater Army and provides centralized control of transportation assets and of time and space on controlled military routes. This control is responsive immediately to theater requirements, thus insuring close integration of supply and transportation support. The MCA operates the Theater Army Movement Control Center (MCC), Highway Traffic Headquarters, Transportation Movement Offices (TMO), and Highway Regulation Points under the staff supervision of the ACofS, Transportation. The MCA provides technical supervision of all subordinate MCCs located in the theater.

The MCA is organized along functional lines to include a headquarters and mission elements as shown in Figure 14. The highway traffic headquarters operates under the staff supervision of the Theater Army ACofS Transportation and under the Command of MCA. Highway Regulation Point teams are under operational control of the highway traffic headquarters. They are stationed at critical locations on the highway net to carry out the traffic regulation plan. The regional TMO (Team LD); air terminal movement control teams (ATMCT); and TMO Teams A, B, and C are under the command and operational control of MCC. The regional TMO reports directly to the Commander of MCA, and, by supervising the activities of the TMOs assigned to regions, the TMOs reduce the span of control of the Commander of the MCA to manageable proportions. ATMCTs have a unique requirement

[17] US Department of Army Field Manual, FM 55-1, *Army Transportation Services in a Theater of Operations* (September 1971).

[18] US Department of Army Field Manual, FM 55-10, *Army Movement Management Unit and Procedures* (January 1977), and *Transportation Logistics* (November 1976).
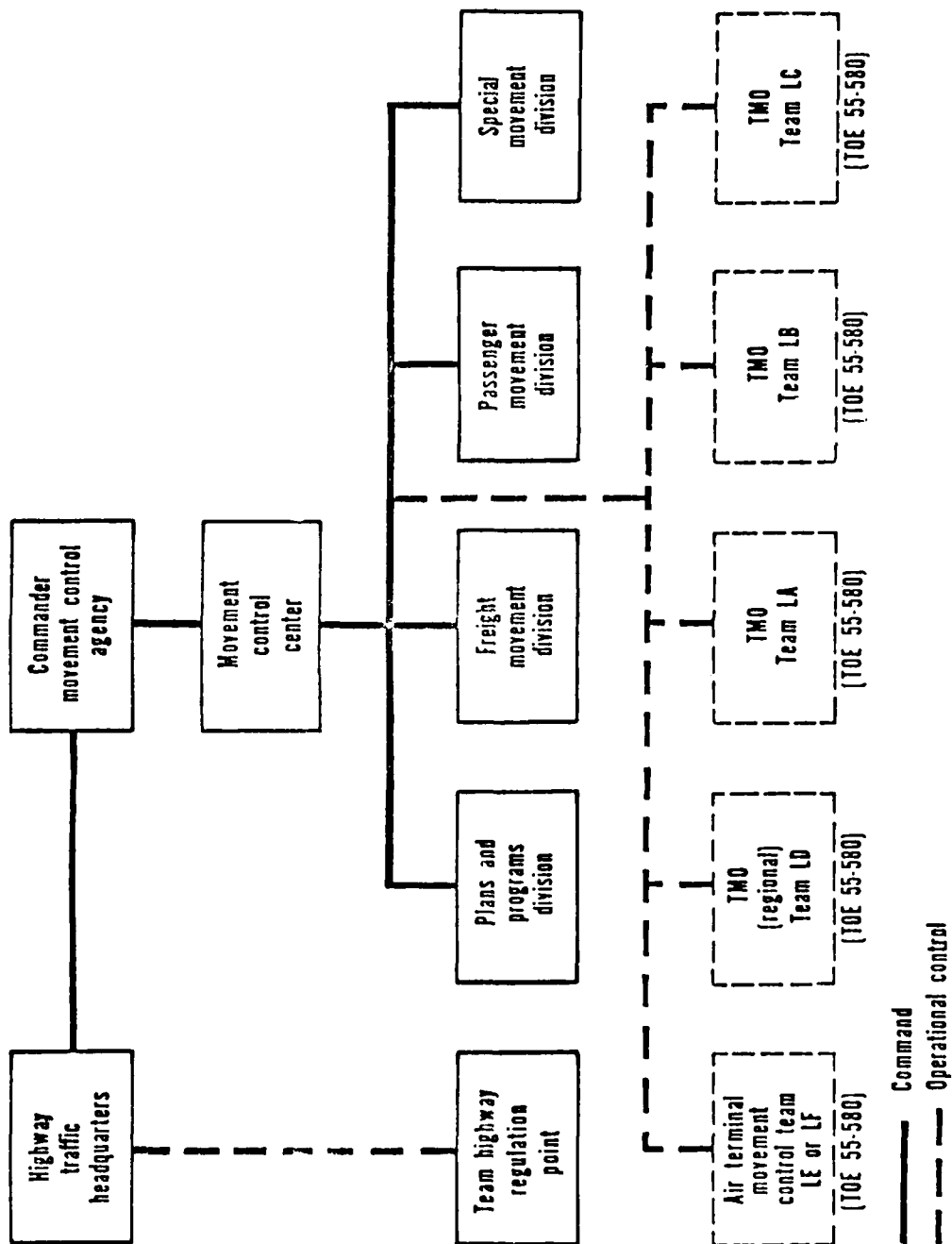
Figure 14. Transporation movement control center of the transportation movement control agency (theater Army).

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for direct access to MCC and Material Management Center to obtain data concerning cargo identification, transportation, and destination or consignee. For this reason, ATMCTs report directly to the Commander of MCA and have access to members of the MCC staff.

e. **Movement Center.**[19]   The movement-management activity of the MCC is carried out by the four functional divisions. The Plans and Program Division is responsible for developing, coordinating, publishing, and distributing the movement program and preparing transportation movement plans to support the logistic requirements of the Theater Army. To accomplish this, the Plans and Programs Division:

● Receives, reviews, and analyzes transportation directives issued by higher headquarters.

● Coordinates information concerning the transportation systems.

● Serves as the focal point of the MCC for computer program problems.

● Determines movement requirements and available transport capabilities.

● Determines capabilities of users to ship and receive traffic.

● Analyzes requirements and capabilities.

● Prepares, coordinates, and publishes the movement program.

● Reviews and analyzes performance data.

● Reviews and analyzes nonprogram movements.

● Prepares movement plans in support of the logistic plan.

The Freight Movement and Passenger Movement Divisions administer and monitor the execution of the movement program and recommend changes to the program as required. They establish procedures and recommend policies for the following major movement actions:

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[19] US Department of Army Field Manual FM 55-10, *Army Movement Management and Procedures* (January 1977).

●   Collection and dissemination of requirements and capabilities data.

●   Establishment of the movement-release system.

●   Consolidation and break-bulk distribution series geared to small-lot shipments for specific consignees.

●   Holding in transit.

●   Diversion and reconsignment.

●   Transferring from one mode of transportation to another.

●   Tracing and expediting.

●   Coordination with the Military Airlift Command and Military Traffic Management Command.

●   Container surveillance procedures for containers and pallets controlled by another service. The Theater Army Container Control Agency maintains contact and running inventories of containers and chassis employed in movements between the continental US and the theater of operations.

The Special Movements Division — the troubleshooting office of the MCC — coordinates and monitors movements requiring special handling. Functions performed by the division include:

●   Allocating the use of scarce, special-purpose equipment.

●   Providing a reporting system on the use of aviation units.

●   Coordinating and monitoring large-unit movements and accompanying equipment.

●   Coordinating and monitoring shipments of chemical and radio-active materials.

    f.   **Transportation Movement Offices.**[20]   The transportation movement offices provide interface between the movement control system and the user and operator.   The mission of the TMOs is to assist the commander in carrying

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[20] US Department of Army Field Manual FM 55-10, *Army Movement Management and Procedures* (January 1977).

out movements of personnel and materiel. To this end, TMOs contribute to the development of procedures, documents, and practices to facilitate movement. TMOs are the common point of contact for mode operators and users of transportation. TMOs act in an advisory capacity to users in the advance planning and coordinating of documentation and in the movement of materiel and personnel into the transportation system. They function in an expediting and coordinating role rather than an operating role, and they monitor traffic moving through the transportation system. When requested or directed, TMOs participate in shipment planning for the activities they serve. To carry out their responsibilities, the TMOs rely to a great extent on close coordination with the mode operating units and the users of transportation. TMOs can provide field assistance in military standard transportation and movement procedures and container control. The TMO is also the point of contact for non-programmed movements. The establishment of a close working relationship between TMO and user within guidelines and policies established by the command will facilitate the work of both. When established, branch TMOs report to district TMOs, district TMOs to regional TMOs, and regional TMOs to the movement control center. Normal relationships follow command channels between the staff of the MCC and the TMOs and generally concern only the transmission of directives and reports. Direct working relationships may be established for emergency or priority action.

g. **Highway and Water Terminal Operations of the Europe Transportation System.**

(1) **Movement Regions of 4th Transportation Brigade in USAREUR.**[21][22] There are three Movement Regions of the 4th Transportation Brigade in USAREUR having different functions and areas of responsibility. The first Movement Region has the responsibility for movement control at all USAREUR ports and, additionally, the area support responsibility of the Bremerhaven complex. However, the United Kingdom (UK) is the responsibility of US Air Forces in Europe (USAFE). Headquarters for the three Movement Regions of the 4th Transportation Brigade is located in Bremerhaven with a Transportation Movement Office (TMO) in Rotterdam and Bremerhaven.

The major function of the 1st Movement Region is terminal clearance of cargo. The 1st Movement Region has no Highway Regulating Team (HRT) or Rail Transport Officer (RTO).

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[21] Defense Communication Agency European Theater Transportation System (ETTS) Vol. 1 (November 1969).

[22] Correspondence from LOG TR.

The 2nd Movement Region is located in Kaiserslautern and is responsibile for movement control of traffic in the theater depot complex. It has offices located as follows:

TMO – Idar Oberstein, Kaiserslautern, Mannheim
FMO – Saarbrücken, Karlsruhe
HRT – Koblenz, Saarbrücken, Karlsruhe

The 3rd Movement Region located at Frankfurt serves customers in an area extending from Munchen in the South to Hannover in the North. Offices are located as follows:

TMO – Frankfurt, Nürnberg, Stuttgart
FMO – Frankfurt, Regensburg, München, Hannover
HRT – Wiesbaden, Ansbach, Stuttgart, Regensburg, München

The 3rd Movement Region, in addition to other functions, is assigned control of US Army owned rail equipment.

Within the theater, the TMOs in the field are the primary operating element. They serve as single points of contact for all DoD customers in their areas for traffic management, movement control, and highway regulation. Figure 15 shows the location of the Regional Field Offices.

(2) **Personnel and Functions of Movement Regions.** The personnel and functions of movement regions are divided as follows:

(a) The 11th US Army Terminal Group is located at Bremerhaven. It operates all ports, and it coordinates with Military Sealift Command for Ocean Shipping and Movement Control Agency for surface movement to and from the ports. Within the group, the Director of Terminals is the staff agency responsible for supervision of terminals operations. Figure 16 shows the organization of the terminals operations.

(b) The Bremerhaven terminal has direct control over the other North Germany ports of Navdenham, Bremen, and Harnburg. The BENELUX Terminal located in Rotterdam controls all port operations in the Netherlands and Belgium including the subports of Antwerp, Zeebrugge, and Amsterdam. The Rhine River Terminal, a subterminal of the BENELUX Terminal, located at Mannheim, is responsible for all operations on the inland waterways along the Rhein and its tributaries. Most of the inland waterway traffic is to and from the terminal at Rotterdam. Although intransit storage is available at most locations, substantially all operations are directly between barge and rail or trucks. These ports are shown in Figure 17.

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BREMERHAVEN

ROTTERDAM

HANOVER

BELGIUM

1ST RGN

GIESSEN

3 RD RGN

KOBLENZ

OBERURSEL

WIESBADEN

FRANKFURT

IDAR OBERSTEIN

K-TOWN

SAARBRÜCKEN

MANNHEIM

NÜRNBERG

ANSBACH

LEGEND

+ TRANS HQ
▼ REGION HQ
◯ TMO
▽ FMO
◯ HRT
▲ TTP

KARLSRUHE

STUTTGART

REGENSBURG

2 ND RGN

MUNCHEN
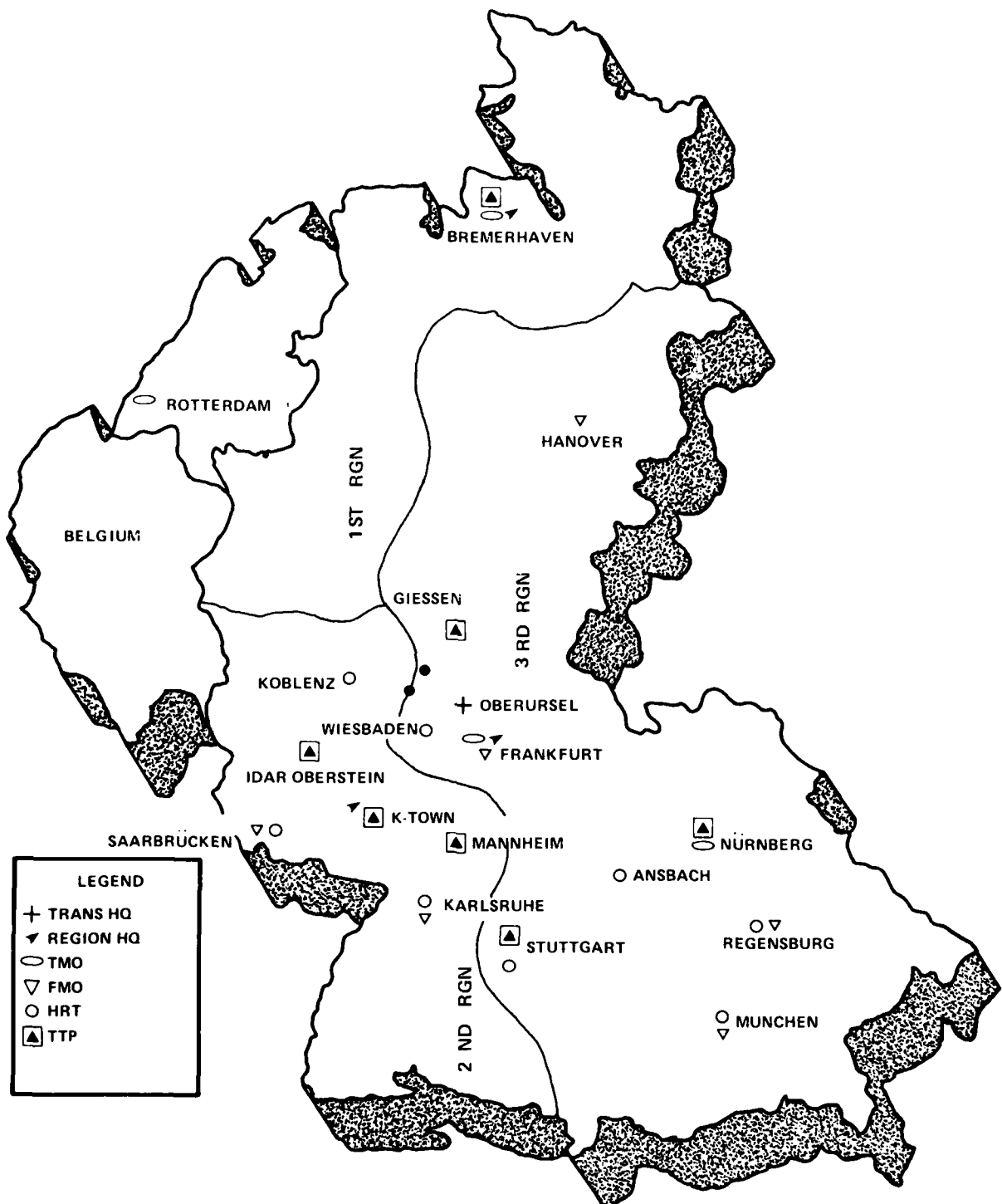
Figure 15. Major movement control unit locations.

35
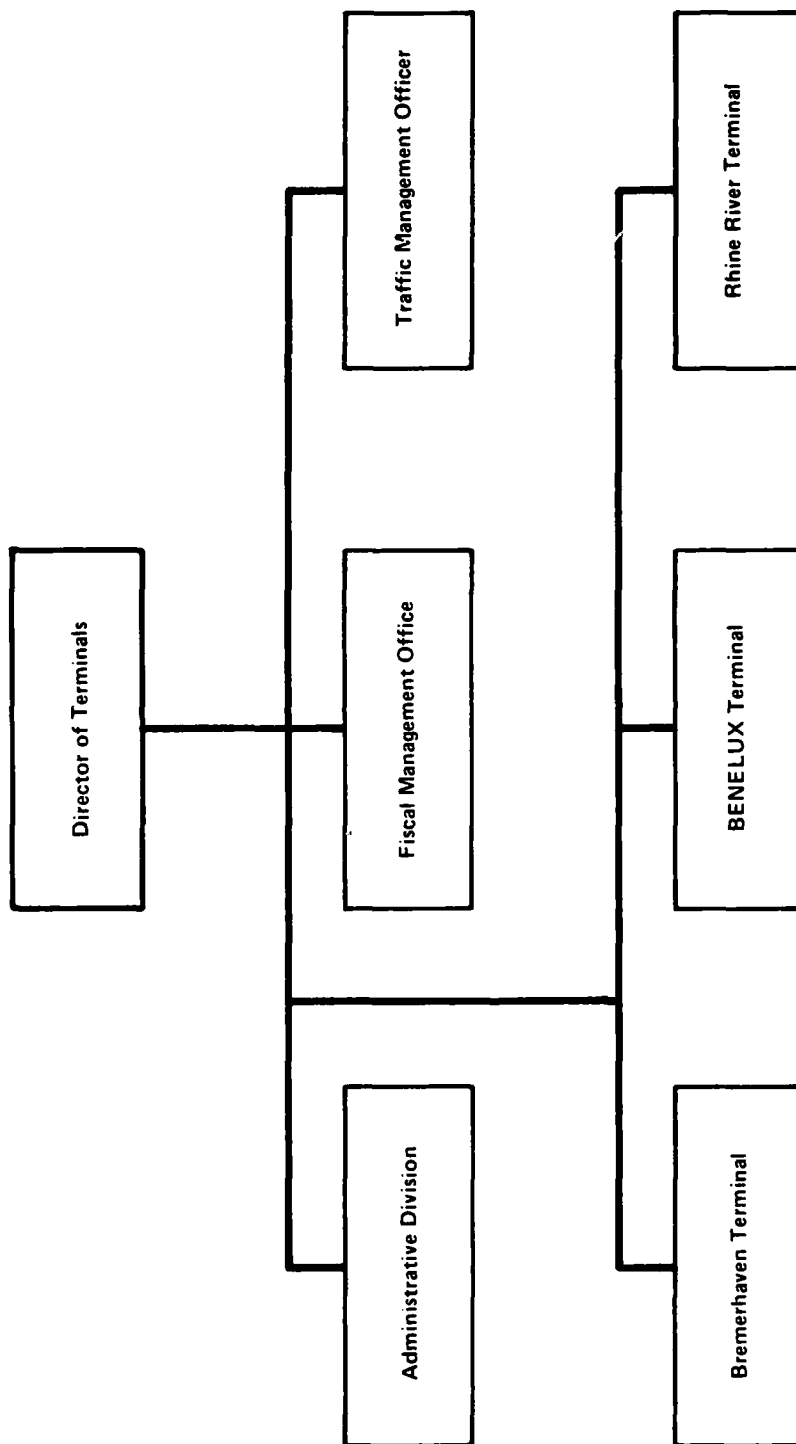
Figure 16. Director of Terminals organization.
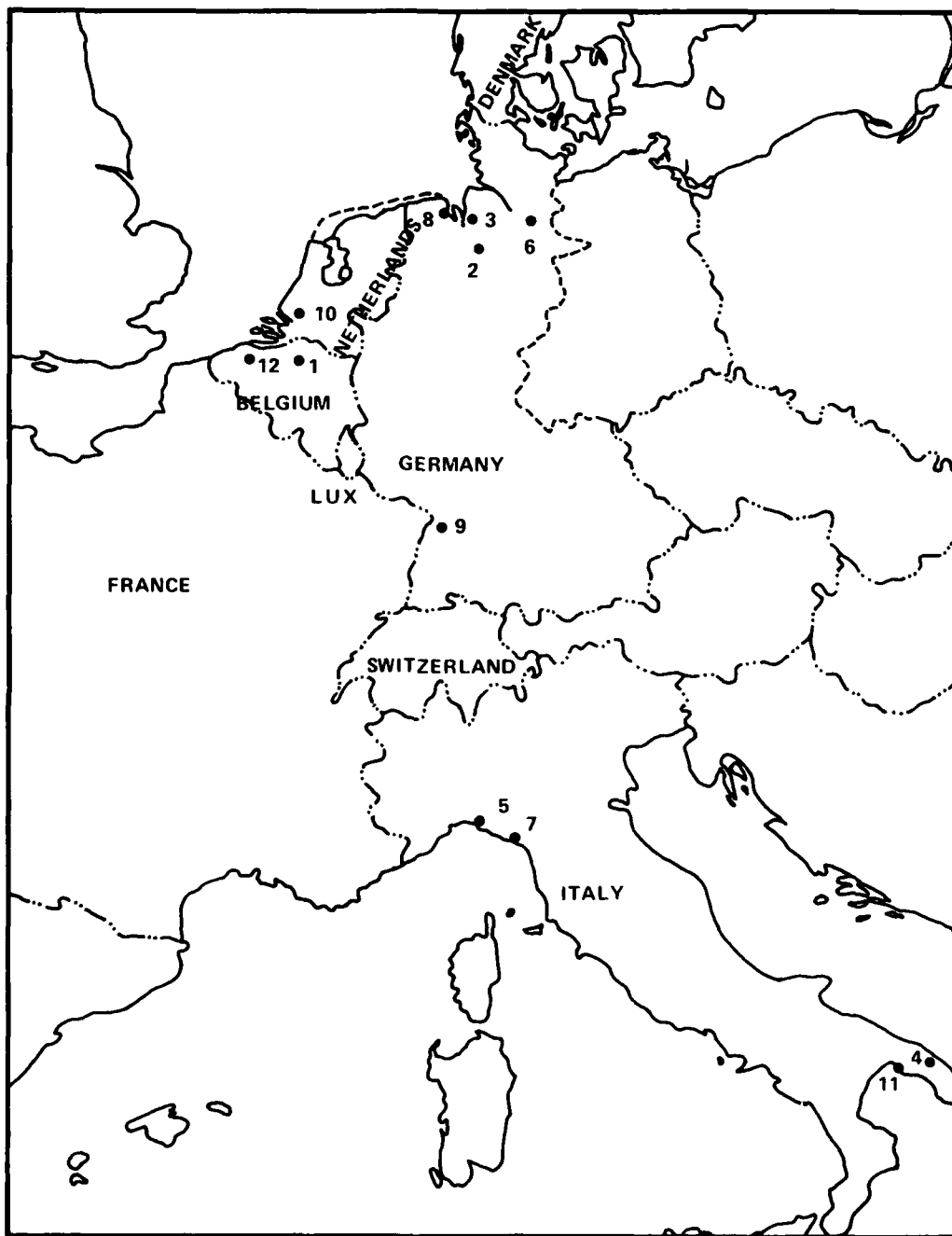
1.	Antwerp	5.	Genoa	9.	Rhine River Terminal Complex
2.	Bremen	6.	Hamburg	10.	Rotterdam
3.	Bremerhaven	7.	Leghorn (Comm & M11)	11.	Taranto
4.	Brindisi	8.	Nordenham	12.	Zeebrugge

Figure 17. USAREUR area water terminals.

(c) The 37th Transportation Group commands and operates all truck transportation units providing theater intersection highway transport service including Berlin. This unit, the only nontactical, military, line-haul agency in the theater, has three battalions and one civilian labor service group battalion located as shown in Figure 18. It operates approximately 1200 tank vehicles from ports of entry along the lines of communication to destinations within the theater. The group operates from Northern Germany and BENELUX port complexes to the Kaiserslautern, Giessen, Mannheim, Nurnberg, and München areas. It operates eight Trailer Transfer Points (TTPs) in accomplishing the line-haul missions. Figure 15 shows the distribution and locations of all TTPs. The 37th Transportation Group maintains the updated information by HFM on trailer and/or truck availability and also receives requests for transportation from supported units.

IV. MANAGEMENT SYSTEMS

9. **Department of the Army Standard Port System.**[23] [24]

a. **Introduction.** The Department of the Army Standard Port System is a subsystem of the Terminal Operations and Movements Management System. DASPS was developed as an automatic data processing system to meet the operating and management requirements of the U.S. Army overseas water terminals worldwide.

b. **Significant Systems Concepts.** Within CONUS, the Military Traffic Management Command AUTOSTRAD systems provide visibility of shipments in transit from the time they enter the Defense Transportation System (DTS) at the shipping depots to and through the MTMC water terminals on the East, West, and Gulf Coasts. MTMC provides advance Transportation Control and Movements Documents (TCMDs) and Ship's Manifests to the receiving ports overseas. At the same time, MTMC provides updating status and location data to the USA Logistics Control Office (USALCO) at the Presidio of San Francisco.

DASPS is primarily an operating system and provides automated assistance in the day-to-day planning, management, and control of shipments. Documentation required for both forward and retrograde movements is computer prepared, and updating information is forwarded automatically to the USALCO. As the Terminal Operations portion of TOMMS, DASPS therefore extends visibility and accountability of shipments from the CONUS ports to and through the overseas ports. At the same time, the DASPS automation of Cargo Disposition Instructions (CDIs) and customs documentation facilities planning for discharge operations and thereby reduces

[23] US Army Computer Systems Command, Department of Army Standard Port System Fact Sheet, Fort Belvoir, VA (December 1976).

[24] US Army Computer Systems Command, *Management Information Systems, Department of Army, Standard Port System (DASPS), Executive Summary,* Fort Belvoir, VA (January 1975).

37th Trans Gp (Kaiserslautern)

106th Bn Ruesselsheim
- 1st Trans Co Nurnberg
- 69th Trans Co Bremerhaven
- 70th Trans Co Giessen
- 78th Trans Co Ruesselsheim
- TTP "A" Bremerhaven
- TTP "B" Bremerhaven
- TTP "D" Giessen
- TTP "H" Nurnberg

28th Bn Mannheim
- 68th Trans Co Mannheim
- 40th Trans Co Mannheim
- 150th Trans Co Mannheim
- 377th Trans Co Mannheim
- 109th Trans Co Mannheim
- 598th Trans Co Mannheim
- TTP "G" Mannheim

6966 CLG Kaiserslautern
- 8363rd CLG Kaiserslautern
- 8364th CLG Kaiserslautern
- 8365th CLG Kaiserslautern
- 8366th CLG Nahbollenbach
- 8368th CLG Mannheim
- 8370th CLG Boblingen
- 8371th CLG Kaiserslautern
- TTP "N" Nahbollenbach
- TTP "F" Kaiserslautern
- TTP "I" Boblingen

53rd Bn Kaiserslautern
- 66th Trans Co Kaiserslautern
- 76th Trans Co Pirmasens
- 89th Trans Co Kaiserslautern
- 501st Trans Co Kaiserslautern

Figure 18. Location of 37th Transportation Group Units.

or eliminates excessive port handling costs and demurrage charges. Other features of DASPS are explained in the following paragraphs.

Although primarily designed to support the Port Commander, DASPS in keeping with MILSTAMP and TOMMS concepts, produces documentation to assist in the movement of cargo out of the port and "down country" to the ultimate consignee. DASPS also supports the Sea Van Management Information System in USAREUR in an offline mode. Under current planning, DASPS will also provide input to the Visibility of Intransit Cargo System which is currently in Detailed Functional System Requirement (DFSR) state in USAREUR and USALOGC.

c. **System Narrative.** The DASPS consists of segments which process transportation documentation related to water-terminal operation. The system performs water-terminal, cargo-documentation functions (import and export), maintains history files on all cargo, and provides an automated means of developing financial data for contract and interservice support-agreement administration.

It produces documentation for receipt planning, inventory accounting, and movement and control of cargo. The system consists of three basic processes: Export, Import, and Activities. The frequencies of runs to accomplish these functions are daily, weekly, monthly, and as-required.

(1) The Export Process. The Daily Export Process provides the water terminal with the means to accomplish automated cargo offering, documentation, control, and the manifesting of cargo exported to other overseas and CONUS ports. Cargo to be moved by water transport is offered to the Water Terminal Clearance Authority (WTCA) on the Transportation Control and Movements Document in either hard-copy or punchcard format. As hard copy is received, it is edited manually and punched into MILSTAMP format for entry into the Standard Port System.

There are four cycles in the export process. The function of each cycle is described in the following paragraphs.

(a) Export Module A Cycle. Module A receives and accepts all documentation for export cargo in punchcard format. As TCMD's and associated trailer documentation are received by the terminal, they are entered into the Daily Export Process, Module A. The data are edited, and an exception list is produced for correction by the user. All valid records are processed through the cycle, and a listing, "Input TCMD/Van Requirement List," is produced.

This list provides the user with a record of all valid data entered into Module A in a particular cycle. Additional cards are produced for re-entry. All cargo (TCMD) processed will be entered onto the Export Master File

and Daily Cargo Status Report which show all valid offerings, their terminal locations (if in port), and vessel identification to which the cargo is planned to load. These items (date of receipt, location, and vessel identification) result from entering the Receipt and Release documents into Module A as discussed in the following paragraph.

As cargo is nominated to a vessel, the Release Card is annotated with vessel voyage number and voyage reference and entered into Module A. This results in posting the vessel voyage number and reference to each Transportation Control Number (TCN) which is to be loaded aboard a specific vessel.

The prepunched Receipt Cards are prepared as cargo is received in port. The cards are annotated with date of receipt, terminal location, and contractor data as applicable and entered into Module A. This action results in posting this data to the Cargo Status Report and will generate cargo-aging information on each TCN located in the port. The Cargo Status Report will show all valid cargo offerings by Port of Debarkation (POD), commodity, and consignee.

Based on data received from MSC through the WTCA and the operations element of the terminal, transportation (documentation, coding) personnel will develop export print requests for the development of cargo-load lists. The load list is developed and printed in POD sequence with military service, commodity break-outs, and totals.

Requests for Transportation Status, Diversion Authorization, and Shipment Hold Documents are also processed in this module. A Tracer Action Report or a reply card, based on the request code entered on the basic document, is generated as a response to the inquiry.

(b) **Export Module B Cycle.** Module B is the ship's manifest module and receives all input pertaining to loading the vessel. The inputs are: Manifest Print Request, Load Tally Cards, Direct Load (from Vehicle) Tally Cards, and Export Master File (Tape Input).

As cargo is loaded aboard the vessel, the load tallies are annotated with date loaded, stow location, vessel voyage number and reference, and contractor data. These cards are entered into Module B.

Upon completion of vessel loading, the Manifest Print Request is entered with the last load tallies, and a Ship's Manifest is prepared along with a Manifest Summary and the Cargo Traffic Message. All cargo loaded aboard the vessel

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for which Load Tally Cards were prepared and entered into Module B will be manifested whether scheduled for loading or not. All documents produced are in MIL-STAMP format. Normally, all cargo loaded will be tallied on the prepunched Load Tally Cards. However, cargo loaded which does not have a Load Tally Card will be manually tallied on a blank Load Tally Card and punched for system entry.

(c) **Export Module C Cycle.** Module C is the final manifest module of the Daily Export Process. It is used to produce the Final Manifest upon completion of corrections, additions, and deletions found subsequent to completion of the Ship's Manifest. This module will accept the following inputs: Manifest Print Request; Load Tally Cards; Direct Load (from Vehicle) Tally Card; Export Master File (Tape); Load Tally Tape from Module B; and Dunnage and Lashing Gear Prime and Trailer Cards.

Card and tape input are both accepted by Module C which initially provides the user with an input validation list identifying errors in the input transactions. These errors must be corrected prior to continuation of processing in order to assure that Final Manifests are as complete and error-free as possible. Continued processing (corrected records) produces the Ocean Cargo Manifest (DD Form 1385), Ocean Cargo Manifest Recapitulation (DD Form 1386), and Ocean Cargo Manifest Summary (DD Form 1386) for dispatch in accordance with MIL-STAMP. Additionally, transceiver decks are prepared for transmission and a Transmission Control Sheet is prepared for record purposes. At the request of the user, a Final Manifest Over and Short Report is prepared.

(d) **Weekly Export History Cycle.** Each week, the export master files are purged of manifested data that are over 14 days old, and purged records are entered on a history file. Concurrently, cargo inquiries are processed and replies provided to requesting activities. In USARPAC, additional data are extracted for preparation of the weekly (PSU) 207 report (Cargo Offering).

(e) **Weekly PSU 207 Reporting Cycle.** The weekly PSU 207 report processing consists of a series of programs for preparation of the report which is utilized by the Western Pacific Movements Office and the Military Sealift Command, Far East (located in Japan). Each user runs this series of programs which creates a hard-copy report and transceives cards for transmission to Japan for preparation of the final report.

(2) **The Daily Import Processing Cycle.** The import process of the DASPS is designed to provide responsive and accurate documentation to the water terminal to promote cargo accounting, terminal clearance, and expeditious through-the-port processing of cargo.

The MILSTAMP Cargo Traffic Message from the POE activates the Import Process. This document provides the information necessary to establish the Vessel Control Register which provides the means of control for all import documentation. The register further provides the terminal operator/manager with a summary of vessel status as to vessels due to arrive, working, and completed and the applicable documentation status.

Manifest data received from the POE are entered into the import cycle as they are furnished. These data are edited and entered into master files which serve as the historical base for cargo entering and processing through the port and as the data respository for inquiry by interested activities on cargo status via the Transportation Movement Inquire (TMI). Exception listings are provided for the purpose of correction of input as required.

The user (terminal) exercises complete control over output production. Upon his request, the Cargo Disposition Instruction (CDI) is prepared. This document serves as the advance manifest for terminal planning and is also used as a notification document for the consignee. To facilitate movement-management as well as port-cargo-clearance procedures, the CDI is printed in Transportation Movement Office (TMO) Area Code, consignee sequence. Based on this document and instructions from materiel managers or consignees, cargo diversions, reconsignments, or stagings are accomplished.

Prior to vessel discharge (normally, prior to arrival), Discharge Tally Lists, Delivery TCMD's, Customs Documents (as required), and Seavan Control Numbers (documents) are prepared. These actions are taken to expedite movement of cargo through the port. The user may also request hatch summaries to assist in discharge operations and Port Cargo Clearance Plans to assist in planning terminal clearance of cargo.

As cargo is discharged, tally date is input into the system; and, upon completion of discharge and request of the user, Cargo Outturn Reconciliation Messages are machine-prepared along with Cargo Over and Short Reports. These documents serve as the initial step in cargo outturn procedures. Upon completion of reconciliation, the system, at the request of the user, will prepare a final outturn card deck for processing and printing the final outturn report.

The cargo-discharge tally provides for insertion of terminal locations as well as date of discharge. These data are used to establish automated-terminal inventories and aging reports. As cargo departs the terminal, a copy of the preprinted TCMD is extracted and the data entered into the system. As a result, the terminal inventory is updated, and control of the TCMD is established. Consignee receipts (TCMD) are also entered into the system to close the TCMD suspense file.

The system has the ability to divert cargo on a TCN basis, or it can be directed to divert all TCNs based on user input. Additionally, it has the capability to accept corrections and cancellations as provided by the user. Through the use of the U59 Transship Delivery Tally, the system will automatically record receipt of import cargo for transshipment and provide necessary input for the export process to effect cargo offerings.

Break-bulk (container unstuffing) is also facilitated by DASPS through the use of the Transportation Address File, activity address codes, and MIL-STAMP designator codes. Upon identifying the container as a break-bulk point within the terminal, a discharge tally list, identified to the container, is developed. Upon completion of discharge and input of discharge tallies (container content), the system provides the user with a Container Discharge Over/Short Report.

A significant feature of the system is that it can accept a manifest, process it, and produce the documentation required for vessel discharge and port clearance in a single cycle.

(a) **Weekly Import History Update Processing Cycle.** The weekly import history update process updates Import History files and also accepts Tracer Requests. Transportation Movement Answer (TMA) cards and Tracer Reply Reports are developed by this process.

(b) **Weekly TCMD Accountability and Port Balance Report Processing Cycle.** The Weekly TCMD Accountability Report results from daily input. Through the computer assignment of a nonduplicative serial number on each TCMD processed, control and accountability are established. As TCMD's are returned to the terminal, the file is updated and, at user request, a report of outstanding TCMD's is generated. The report provides the control necessary to assure proper maintenance of the ship's file and provides a means of maintaining a positive receipt system.

The Port Balance Report is also developed in this process. It provides three basic breakouts of cargo and serves as a cargo-aging report. Part I of the report shows total tonnage by area destination; Part II shows total tonnage by port location and area designation; and Part III provides a detail listing of cargo awaiting clearance. These reports provide the data required to control and account for import cargo transiting the Port.

(3) **Activities-Processing Cycles.** The Activities-Processing Cycles utilize data from both the export cycle and the import cycle to prepare the daily, weekly, semimonthly, and monthly reports provided to the terminal managers.

(a) **Daily/Weekly, Activities-Processing Cycle.** The Activities-Processing Cycle accepts the load data from the export cycle and the discharge/delivery date from the import cycle for re-formatting into records used to create the desired management-output reports. Records to accomplish contractor billing, interservice billing, container reporting, and statistical tonnage reporting are created.

(b) **Weekly Contractors Activities-Processing Cycle.** The contractor activity process receives tape input from weekly activities files which carry contractor data from daily input. Contractor Master Files containing contractor rate information are also input into this process for the development of Contractor Detail and Summary Reports. Currently, this process handles only commodity and tonnage cost determination. Manhour accounting is projected as a future task to be accomplished.

(c) **Semimonthly Container-Processing Cycle.** The Semimonthly Container-Processing Cycle is used primarily in USARPAC. It is designed to accept input from container reports provided from within the area serviced by the terminal. As a result of this input and of input resulting from daily processing, military container accountability is maintained.

(d) **Monthly Activities-Processing Cycle.** The Monthly Activities-Processing Cycle consists of a series of programs which manipulates all data received from daily and weekly processes to produce statistical and financial reports. These reports include port cost-handling, consolidated tonnage, and workload programmed versus actual workload accomplished. Ships agents' billing reports are also available on user request. The system further provides the capability for functional user intervention to post adjustments or corrections as required.

10. **Highway Fleet Management System.**[25] [26]

a. **Introduction.** The 4th Transportation Brigade currently supports USAREUR units/facilities by transportation of supplies using road, rail, and air movements. Road movement is accomplished with internal assets; rail and air movements are coordinated with local carriers. To insure timely servicing and total commitment fulfillment, the 37th Transportation Group uses the Highway Fleet Management System to manage its resources. The system consists of master records maintained by an IBM 360/40 computer which accounts for each trailer assigned to the Group and the commitments for military highway movement performed by the Group. The master file is updated daily to give the latest reported status of a vehicle or commitment.

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[25] US Department of Army, *MSEES Manual For the Highway Fleet Management System.*

[26] Correspondence from LOG TR.

It provides information to insure known trailer location at all times, to trace and break loose frustrated movements, to monitor current commitment status and thus avoid slippage, to provide maintenance status, to provide performance data for the interface between units, and to preserve historical information for resolving questions on past commitments.

General objectives are to provide the Commander, 37th Transportation Group, with data-processing support commensurate with his need for fleet management and interface with the current operational system.

    b.   **Primary Documents Used in HFM.** The primary documents used in the HFM system to establish and update the trailer and commitments records are:

    (1)   Daily Installation Situation Report (DISR).

    (2)   Updated Commitment Master Reference Listings.

    (3)   Daily Capability and Utilization Report (DCU).

    (4)   Yard Checks.

    (5)   Trailer Movement Status Logs (TMSL).

    (6)   Trailer Movement Reports.

    (7)   Transportation Control and Movement Documents (TCMD).

Processing of these reports results in the Master Reference File being updated with the newer information as to commitment status, trailer location, and trailer status. Outputs are in the form of 21 separate reports and reflect the new status, status date, and location as provided. The IBM 360/40 computer receives the above inputs in the form of general-purpose punch cards. Keypunching is performed on IBM 026 cardpunches located at the 37th Transportation Group.

    c.   **Users of the HFM System.** The following components are the users/ generators of the information processed by the HFM System:

    (1)   37th Transportation Group.

    (2)   Motor Transport Clearance Authority (MOTCA).

    (3)   Army Air Transportation Coordinator (AATCO).

(4) Traffic Management Office (TMO).

(5) Trailer Transfer Point (TTP).

(6) Kaiserslautern Cold Storages (KCS).

Figure 19 shows the interactions among these parties.

    d. How HFM System is Used. The HFM System has been designed to provide up-to-date information on all commitments and trailers assigned to the 37th Transportation Group. This is achieved by maintaining machine records on each of the following:

    (1) Permanent record of every trailer assigned to 37th Group Fleet to include type of trailer and maintenance service requirement due.

    (2) Temporary record of every daily commitment assigned to the 37th Group to include current status.

    (3) Temporary record of all trailers in either uncommited or dead-lined status.

    As the status of a commitment or trailer changes, the 37th Transportation Group inputs this information into the computer which, in turn, updates the particular record with the change. These changes in status are reflected in the daily reports. All commitments which have been completed are retained in the computer for processing the weekly report and Weekly Performance Report and are then removed from the file along with cancelled commitments. The trailers assigned to these commitments are given a status code of empty/available automatically.

    e. Purpose of the Primary Documents. The primary documents listed in paragraph 10b are designed to provide updated information at different levels. The purpose of each document is described as follows:

    (1) Daily Installation Situation Report (DISR). The DISR is submitted on a daily basis by the TMO's. Customers within the TMO area of responsibility submit information on the status of trailers and commitments which is consolidated by the TMO and forwarded to 37th Transportation Group via telex.

    (2) Updated Commitment Master Reference Listings. These listings are prepared by the Battalion Operations Sections and serve to update the status of commitments which have been assigned to the battalions. They also include all new commitments assigned as add-ons throughout the day.
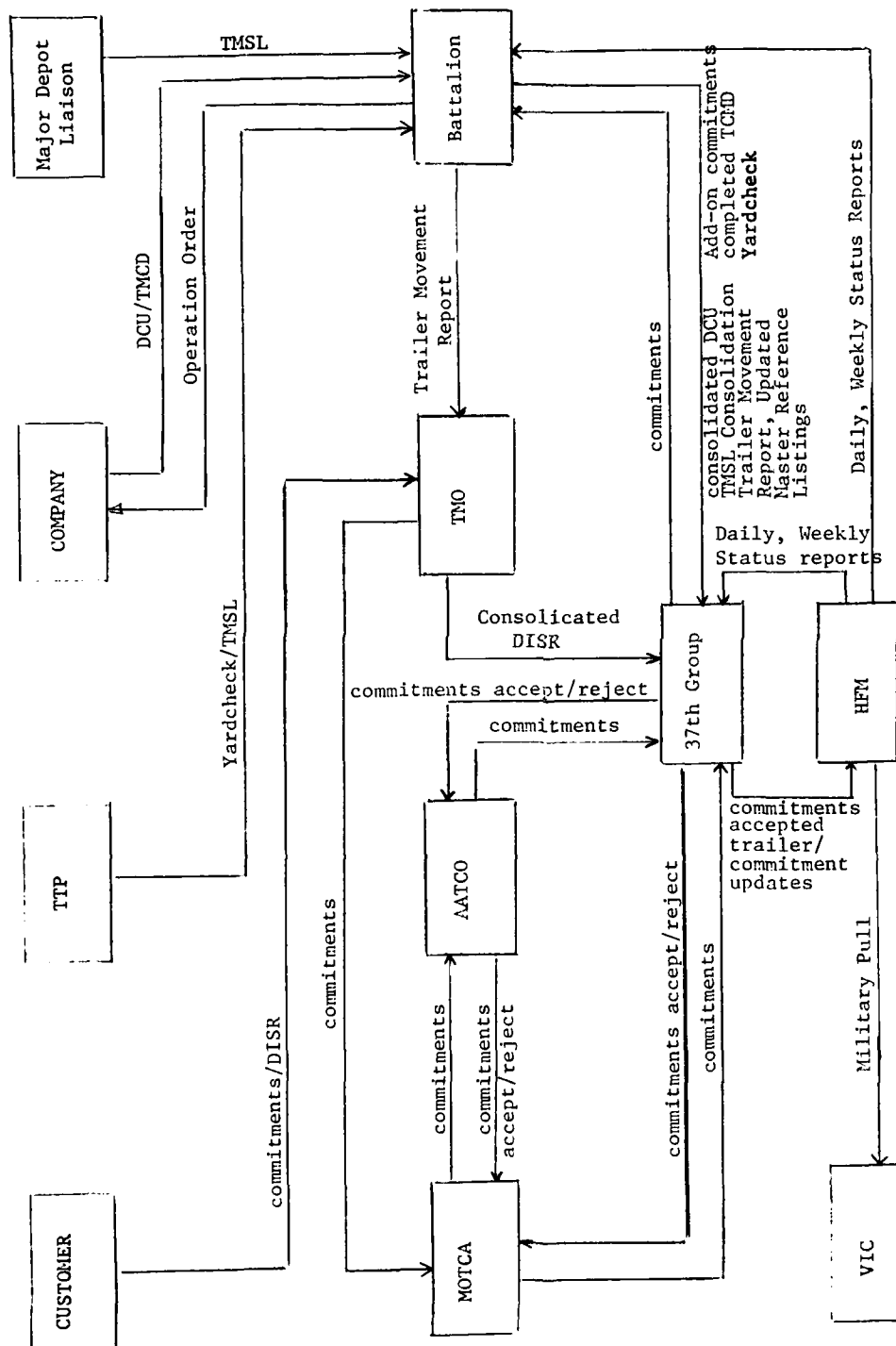
Figure 19. Highway Fleet Management System (HFM).

(3) **Daily Capability and Utilization Report (DCU).** DCU's are consolidated at each battalion and represent the battalion's forecasted driver and vehicle capability for the day and includes the tonnage on each trailer for a commitment currently assigned to that particular battalion. The DCU's must be delivered to the 37th Transportation Group no later than 1000 hours each morning.

(4) **Yard Checks.** This report, prepared daily by the Trailer Transfer Point, includes a listing of all trailers which are located at the TTP, the status of the trailer, the reference number, and the required delivery date if applicable. Yard checks should arrive at the Group no later than 2100 hours.

(5) **Trailer Movement Status Logs.** These logs are also submitted by the TTP and the Major Depot Liaison Sections. The logs reflect the flow of trailers through the TTP or major depot and must also arrive at the Group no later than 2100 hours.

(6) **Trailer Movement Reports.** These reports are submitted from each battalion to all TMO's with an information copy provided to the Group. The reports indicate battalion actions taken with regard to commitments. Reports are transmitted via telex.

(7) **Transportation Control and Movement Documents.** TCMDs are consolidated at each battalion and forwarded to Group. They represent proof of completion of a commitment and provide the actual tonnage figure for each commitment.

f. **Daily Processing of Documents.** The daily processing of documents of the HFM System can be described briefly as follows:

(1) Initially, DCUs and completed TCMDs (driver copy) are compiled at each company level and forwarded to the respective Battalion for consolidation.

(2) The consolidated DCUs are used in compiling the Motor Transport Forecast — a forecasted estimate of the driver and vehicle capability for the following day.

(3) The completed TCMDs represent proof of completion of a commitment and provide the actual tonnage figure for the commitment.

(4) The consolidated DCUs and TCMDs must be delivered to S-3, 37th Transportation Group, NLT 1000 hours each day.

(5) Yard checks and TMSLs from each TTP are forwarded to the respective Battalion and then to 37th Transportation Group NLT 2100 hours each day.

(6) Yard checks and TMSLs specify trailer location, maintenance condition, and status of all the trailers moving into and out of the TTP for that day.

(7) The TMSLs, Yard checks, and completed TCMDs are used by Battalion in updating their copy of that day's Commitment Master Reference Listing.

(8) Each Battalion then delivers (either by courier or telex) the consolidated DCU, updated commitment Master Reference Listing, TMSLs, Yard check, Motor Transport Forecast, and all completed TCMDs to S-3, 37th Transportation Group.

g. **Relation Among Offices and Input Documents.** The relation among offices and input documents from the various sources under the HFM System for the daily business can be described as follows:

(1) Group S-3 receives commitments from MOTCA, USATRANS-COMEUR, KCS, and AATCO.

(2) Based upon projected personnel and vehicle availability, the S-3 accepts and refuses commitments.

(3) The accepted commitments are assigned to battalions and are placed into the computer.

(4) Each battalion, at the close of the day, submits a Trailer Movement Report to each TMO in whose area of responsibility the action took place; an info copy of same is telexed to Group operation.

(5) Each TMO submits his DISR to the Group giving the status and location of all 37th Transportation Group trailers located within his area of responsibility.

This, in general, describes the flow of input documents from the various sources. All inputs listed are keypunched by the Group DPU (data-processing unit), and the card deck is taken to Kaiserslautern Army Depot (KAD) for processing.

h. **Output of the HFM System.** The output of the system consists of the daily reports and weekly reports. Daily reports provide up-to-date data on all commitments to include present status, whether pending spot or pull, whether past required delivery date (RDD), and number of days since commitment record was last dated. Daily reports are also generated which provide current trailer data to include present status (committed; noncommitted; location; service due, if any), number of empty trailers available for commitment and a listing of "false" trailers (i.e., trailers which fail to meet edit criteria as valid 37th Fleet Trailers). In addition to the daily reports, there is the Weekly Performance Report which provides a detailed listing of commitments having been completed to include the difference in days between required and actual spot, pull, and delivery dates for each completed commitment.

11. **Visibility of Intransit Cargo.**[27] The VIC system is an automated, functionally oriented operational/management information system designed to establish and maintain an individual record of each MILSTAMP shipment unit entering a theater of operations through either the water or aerial ports of debarkation and to maintain the visibility of the shipment unit until it is delivered to the consignee.

The system concept received DA approval in May 1973. In November 1974, the VIC system was designated as a potential Department of the Army Standard system and released in May 1975 for programming. DA envisioned the VIC system to serve as the baseline system for the Cargo Movement Module of the conceptual DA Movement-Management System (DAMMS) — a comprehensive system to be developed to assist the Theater Army Movement Control Center in performing its functions of total movement management (cargo and passengers), movement planning, and performance analysis for the transportation system operating in the Theater Army.

The system will provide management feedback for all cargo in the theater portion of the transportation pipeline. VIC will be developed in four phases: Phase I for the Import Cargo (VIC-I) (as outlined below); Phase IA for container applications; Phase II for Intratheater cargo; and Phase III for Export cargo movement. By DA direction, VIC-I is being developed initially as a European-unique subsystem with USAREUR DCSLOG as proponent and the 4th Transportation Brigade as ARA. VIC-I will be developed in such a manner that it can readily be converted to DA standard. VIC-II and VIC-III are planned to be DA standard from the outset, with DA DCSLOG as proponent and HQ USACSC as assigned responsible agency (ARA). USACSC Support Group Europe is the ASD for all phases of VIC development.

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[27] Army Computer System, *Visibility of Intransit Cargo (VIC)*, Executive Summary (January 1978).

The objectives of VIC are as follows:

a.   Provide the theater commander with visibility of all cargo from the theater point of origin to the theater point of destination. This includes all levels of shipment consolidation and movements as well as the single-shipment unit.

b.   Provide the theater commander with the ability to change the consignee of cargo at any point in the theater transportation pipeline. The change may be for a single-shipment unit or it may be for an entire movement.

c.   Provide the theater commander and logistics manager with positive feedback of receipt at destination. This information is passed to the Logistics Intelligence File (LIF), the DoD Intransit Item Visibility System (DIIVS), the Standard Army Ammunition System (SAAS) Level 3, and the Vertical Integrated Management of Subsistence (VIMS).

d.   Respond to inquiries concerning current status of a shipment unit. All inquiries currently identified will be by TCN. Requests for change of consignee will result in status information concerning the movement being provided as well as the TCN data. VIC will be the primary automated interface with the Theater Logistics Intelligence file (FINDER) in that VIC will accept status inquiries and provide current status.

e.   Provide necessary data bases for statistical analysis, detention management, and movement analysis.

The VIC data base is composed of shipment unit TCNs and consists of three master files:

- Cargo File.

- Movement File.

- Cross-reference File.

The VIC master files are initiated primarily from two input sources:

- Advance ocean cargo manifest from MTMC Ports of Embarkation (POE).

- Terminating air cargo data from Military Airlift Command (MAC) Aerial Port of Debarkation (APOD).

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As the master files are initiated, advance notification of cargo arrival is provided to cargo consignees. Various updates are then received via the communications-support network which provides new status information for the records as each SEAVAN and breakbulk MILSTAMP shipment unit arrives, is discharged, and begins its movement to destination. These updates can be categorized as those received from the Water Port of Debarkation (WPOD), APOD, AATCO, area MSC office, commercial SEAVAN carriers, TMOs, and the Theater Transportation Command Group(s) or its subordinate units.

The WPOD provides updates by reporting vessel arrival, discharge information, and departure of breakbulk cargo from the WPOD. Data are produced by the DA Standard Port System and transceived via AUTODIN to VIC; this updates the VIC master files by either SEAVAN, RORO (roll on/roll off), consolidation, or loose shipment unit TCN and will advise of landed status for MILVAN/SEAVAN.

Subsequent information provided by the WPOD cross references Transportation Movement Release (TMR) number and transport number to the TCNs loaded on the conveyance and updates the master files upon cargo departure from the WPOD. VIC maintains visibility of split shipment from the WPOD (multiple conveyances, for a single TCN), multiple-stop conveyances (cargo for several consignees on a single conveyance), and single-stop conveyances (multiple TCNs on a single conveyance) until the cargo arrives at the consignee/stop consignee.

Military Sealift Command provides update information on commercial SEAVAN status such as container lease data, staging release from staging, terms of carriage change, and container damage or failure. Commercial SEAVAN carriers also provide update data relating ETA of the SEAVAN at the WPOD and requests for missing documentation and commencement of inland drayage for each SEAVAN drayed by the carriers.

After the terminating air cargo data have been provided to VIC, the APOD updates the files with a truck manifest indicating, by TCN, the shipment units actually loaded aboard the conveyance and the conveyance number. The Army Air Traffic Coordination Office, in turn, submits advice to VIC of date departed and TMR number when the conveyance departs the APOD. VIC cross references TCNs to TMR(s) and transport number(s) indicating APOD departure for highway shipments, and, based upon advice provided by the APOD, closes unit pick-up records as received at destination.

Subsequent cargo movement is reported at all major nodes in the theater transportation system via the supporting communications network and updates the status of the shipment unit record on the VIC files.

The Transportation Command/Group(s) and subordinate units provide shipment unit status updates by TMR and transport number to the VIC master files on arrival of the conveyance at a Trailer Transfer Point or arrival at destination.

Transship Points (TSP) provide arrival/discharge data at the TSP either by TMR and transport number, SEAVAN TCN, freight warrant number and transport number, or by shipment unit TCN. Subsequent cargo departure from the TSP is reported to VIC by shipment unit TCN and cross referenced to the TMR number and conveyance on which it is loaded.

The TMO(s) provide advice to VIC of commercial conveyances, SEAVANS, and rail movements entering or terminating in the area(s). Data reported by the TMO are conveyance arrival, discharge, and departure. Upon notification by the TMO of SEAVAN discharge, the MCC advises the carrier that the SEAVAN is ready for pick-up/onward movement as appropriate. TMO status updates are based upon data received from the cargo consignee(s).

The consignee reports cargo arrival by either TMR and transport number, SEAVAN TCN, shipment unit TCN, or freight warrant number and transport number to the servicing TMO and provides other update information such as shipment unit discrepancies, discharge status of the conveyance, container failure, and container maintenance. For multistop conveyances, these data are reported by the TMO from information received from the stop consignees. Accurate and timely response by the consignee to the TMO reporting events as they occur is a vital part in maintaining status and closing the loop on individual shipment unit records cargo.

VIC maintains/provides cargo status and movement control data from the constant file updates and nodal reporting as the cargo moves through the theater transportation system. The system provides advice to the manager or takes action on cargo hold requests at any time prior to cargo arrival at the consignee. Similarly, a request for change of consignee may be approved by the MCC and affected if the conveyance on which the cargo was loaded has not departed the separate consignee location. If cargo is reconsigned, the system maintains visibility of the reconsigned cargo until its arrival/discharge at the new consignee. VIC provides intransit data cards reflecting actions at certain nodal points in the theater to CONUS-based systems. Also, VIC has the capability to accept MILSTAMP tracer actions (TMI) and to provide MILSTAMP tracer replies to the tracing activity giving the latest reported status of the cargo within the system.

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Within the area of container management, comprehensive management reports are provided to the MCC traffic managers and Military Sealift Command concerning potential detection costs and potential detention statistics. As advance ocean cargo manifests are received, the system has the capability to automatically screen incoming containers, compute inland drayage costs for potential terms of carriage change, and identify these containers for military drayage to the MCC along with the potential dollar savings to be realized.

Managerial inquiry and a parameter-defined extract capability provide for cargo status and movement performance/analysis reports as outputs of the system. Further, cargo and/or movements history data, as well as system performance data, are systems outputs. The system execution parameters are user-controlled, allowing reports(s) production to be activated or inactivated as desired for any particular output report during any production cycle. System control data are controlled by the functional systems manager by employing the wide use of user-maintained tables instead of an imbedded code. Input document analysis is performed by the system, and error statistics are provided to the manager to aid in improving system operation and validity of system outputs. For input documents which contain errors, re-entry documents are formatted and provided requiring only the error to be corrected and the input resubmitted to the system.

The VIC file design allows the MCC traffic manager, using a general extract capability, access to any data in the data base for cargo or movement-management analysis purposes. Extract capabilities may be exercised during any desired processing cycle. The file design permits continual cross-referencing of the shipment unit to the conveyance on which it is being physically moved within the theater transportation system. As a result, system update data can be entered by TMR and transport number, TCN, SEAVAN number, freight warrant number and transport number, or voyage document number for ease of reporting at nodal points in the theater transportation network.

V. DISCUSSION

12. Applications of CCIRS.

a. Introduction.

(1) **Effective Use of CCIRS.** CCIRS can perform or assist either or both of the following functions:

(a) Manage local cargo and traffic.

(b) Support and enhance a system efficiency and capability.

The places that CCIRS can be used effectively are locations with significant volume of container traffic or at remote checkpoints. In the three applicable systems – DASPS, HFM, and VIC of the Theater Army Europe – those places are shore area, marshaling yard, nodal point, TTP, TSP, depot, and consignee areas. CCIRS has three parts: label, interrogator, and terminal device. The label, in general, is attached permanently to a fixed location on a container and the transport equipment with a program of identification code. The international code which has worldwide recognition is recommended for the container label. The fixed locations of all containers or transport equipments should be geometrically consistent. This will ensure an efficient operation for the interrogator. However, occasionally there are instances where the container is loaded on a trailer with front/back reversed. To deal with such instances and to ensure the perfect scan result for the interrogator, one of the following actions is recommended:

- Two labels are attached – one on each side of the container. This action will increase cost a considerable amount on capital equipment because cost of label is the largest expenditure among all expenses on hardware purchase for CCIRS.

- Set up the interrogators so that both sides of the container can be scanned during the operation. However, there will be instances where the other side of the container cannot be reached easily by the interrogator.

- Attach extra marks or devices on a container and on the trailer to ensure that the container can be loaded on a trailer or staged in a marshaling yard one way only.

Before making a decision from the above choice of actions, we suggest a field investigation as well as an opinion from the actual field operator. This ensures that the factor on field practice is not omitted in the consideration.

The interrogator should be set up at key points of significant cargo traffic passes. During the cargo movement, the interrogator will scan and record the labels carried by the container and/or its associated transport equipment. The data gathered by the interrogator is transmitted immediately to the terminal device for editing or other actions according to programmed schedules.

The terminal device can be either a simple data buffer or a mini-computer, depending on requirements of the operation. The CCIRS which has the minicomputer as a terminal device possesses data storage and processing capabilities; therefore, adequate software will enhance the CCIRS' capabilities and performance

tremendously. The CCIRS will accept input from the interrogator as well as other sources, manipulate the data, and produce scheduled outputs in a form that the system will find most beneficial.

(2) **Functions of CCIRS.** For an adequate setup, CCIRS will assist or provide the following functions:

(a) Inventory check.

(b) Trace and search operations.

(c) Cargo inventory and transport asset record.

(d) Operation record.

- A complete list of daily operations.

- An extracted, partial record at user's desire.

(e) A real-time or edited information transmission for other party or parties.

(f) Extra assistance to the cargo traffic regulation and cargo management operations:

- Visual display or printout on real-time or edited information.

- Indicating to the operator the traffic volume and traffic volume per unit time.

- Indicating the operator on cargo special handling, treatment, staged area, loading area, or loading ship for a container cargo and transportation requirement.

The required input-data elements for each of the above operations are discussed in the following paragraphs.

(3) **Potential Benefits of a CCIRS System.** With the data storage and data processing capability at the terminal device, the CCIRS is able to perform the above functions with an adequate setup, software interface instruments, and

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supporting communications networks. Potential benefits to a system or operation with the application of CCIRS are as follows:

(a) More efficient utilization of marshaling-staging area and transport assets and reducing nonproductive container time.

(b) Provide flexibility and immediate responsiveness in satisfying the user's need.

(c) More efficient operation and management due to the following reasons:

- Automatic identification and recording with accurate data.

- Real-time information on traffic pattern.

- Better projection on time, manpower, and equipment requirements for completion of an operation with fast and accurate data base.

- Reduce manpower and operation cost.

- Direct communication or transmission of data with other parties, eliminating extra documentation and errors.

- Assistance and answers to the trace inquiries.

- A complete systematic operation file.

- Records data for works on operations planning.

b. **Supporting Requirements.**

(1) **Input and Output of CCIRS.** Rapid information and knowledge of the status of supply items and associated transport equipments is the main purpose of the CCIRS. This includes the identification of the item, knowledge of the time and location of the item, and the status of transport equipment within the transportation system. The data supplied by the CCIRS are identification codes for the container and associated transportation equipment. These numbers must be in reference to information from certain supporting documents; therefore, the detailed information about the cargo and its associated transportation equipment can be deferred.

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In the present logistic supply and transportation system, there are enough documents with sufficient information to indicate the commodity, classification of freight, required delivery date (RDD), consignee, etc. Therefore, the main concern is a cross reference which leads the CCIRS data to the documents with the needed information. The data base of VIC has been designed to meet this requirement. It is composed of shipment unit TCNs and three master files: a cargo file, a movements file, and a cross-reference file. This set of documents has the entrance capability from the information of container to shipment contents and conveyance and vice versa. VIC master files are updated by every new status of shipment. A minor modification may be needed to make this VIC file suit the CCIRS operations. However, the modification and the structure of the files are out of the scope of this study at the present time. A follow-on study including the development and application of the files is suggested.

During the application of a CCIRS, the direct input from the interrogator is the I.D. code from the container and/or the transportation equipments. This information will be either through the data buffer transmitted to the party or parties who need the information or sent to the teminal with data storage and processing capabilities. The first application of CCIRS is simply an automatic data collector which has the sole input from the interrogator except the possible control input from the operation. The second application of CCIRS can be multipurpose. The functions and capabilities of the CCIRS in an operation will depend on the software developed for the terminal device. The input and output of CCIRS are also dependent on the function requirements and software of the CCIRS described in paragraph 6. For a particular application, only selected input and output will be designed in the software according to the function requirements. The possible inputs for these applications can be as follows:

(a) From the interrogator: I.D. codes of containers and/or the transportation equipments.

(b) From the operator: input for commanding the device operation.

(c) From other sources: input that requires the CCIRS to perform the following special-purpose operations:

- Cargo tracing and inquire answering.

- Special instructions for cargos and transport equipment TV handling.

● Extracted partial information on an operation record in a form and time period or location according to user's demand.

The CCIRS terminal can generate the following:

(a) The instant display of the information from interrogator and/or real-time-information transmission for other party or parties.

(b) Lists of operation records (edited information) for display and/or transmission.

● A complete daily record with time and location in a form by the user's demand.

● An extracted partial information of the operation record.

(c) Response to the tracing and inquiring action.

(d) Special instruction for cargo and/or transportation equipment handling. The output of the CCIRS terminals can be in one of the following formats:

● Real-time and/or edited information transmission to other party or parties.

● Video display or printed copy.

● Tape, disc, or punched cards.

● Special mechanical or visual indicators.

(2) **The Communication Network and the Interface.** As mentioned previously, one of the essential elements for a successful operation of CCIRS as a system is a full support of interface instruments and communication networks.

Effective and rapid transfer of data is essential to the original objectives of CCIRS. Besides the information collected by CCIRS used for local cargo and transport equipment control and management, the CCCIRS data will be transferred through the existing communication channel to the designated logistic control and transportation centers or offices. The present Military uses telephone, Telex, and AUTODIN for this purpose.

AUTODIN is specially designed to provide economical and reliable data communications service both for interactive timesharing and transaction-oriented systems requiring rapid response between terminals and computers and remote job entry and computer-to-computer data-transfer requiring high-transmission capacity intermittently. The current tendency of adopting ADP widely as standard equipment in logistic and transport management and fast development in AUTODIN II networks will make AUTODIN used more often in communication for logistic control and supply; that is, part of debarkation, movement control center, transportation movement offices, marshaling area, TTP, general-support supply activities, direct-support supply activities, division support commands, and mode operations. All must have access to the AUTODIN net in order to report and obtain container and associated transport equipment status information.

Computers are located at the major theater terminals and at the transportation command. These computers have a data storage capacity that can accommodate current files of container movement data. The master container file is located at TA, where it is managed by a movement-control agency.

The interface has two parts – hardware and software – which couple with communication channels to transmit data among CCIRS and other parties. It may also require interface devices among the CCIRS terminal and local peripheral devices which include the information display devices, special-purpose indicator, and switch devices. The detail design of the hardware and the software is not in the present scope of this report. This design requires highly skilled professionals on instrumentation and data-processing techniques. The present common-user communication networks for Military and logistic supply are AUTODIN, Telex, and telephone. The interface between AUTODIN and CCIRS has been established. The interface with Telex can also be done easily. Probably, on some occasions, the capability to transmit digital data through telephone will be considered convenient. There could be instances for CCIRS in which the only proper means to use AUTODIN is through telephone.

c. **Application of CCIRS in DASPS.** Besides the applications of CCIRS in the local traffic regulation and cargo management within the port areas, CCIRS can be used to enhance DASPS capabilities and functions. The applications of CCIRS in DASPS along with the function procedures of the DASPS are described as follows:

(1) Application of CCIRS in the Export Process. When DASPS completes the processing of all cargo TCMDs, an Export Master File and a Daily Cargo Status Report are produced. This file and report shows all valid offerings, their terminal locations, and vessel identification to which the cargo is planned to load. DASPS may transmit information into the memory CCIRS terminal. The interrogator reads and matches the data in the terminal for a certain cargo to a certain terminal location

for loading or staging the video display or an automatic indicator to indicate to the driver the location where his cargo is to be unloaded. Upon the completion of the daily operation of all cargos, CCIRS transfers its daily record to DASPS export process module A where a final check between CCIRS data and daily cargo status is made. If there is any difference or error, the person responsible for this operation is notified immediately.

The export module A is also responsible for answering requests. The requests for transportation status, diversion authorization, and shipment-hold documents, in general, are processed in Module A. Any request for cargo container(s) identification and locations can be formed as an input to the CCIRS terminals. The CCIRS may perform either or both of the following actions in response to a search request:

(a) The CCIRS list of records is checked to identify the existence of the requested container and its historical time and locations.

(b) During real-time operations, whenever the interrogator senses the requested container(s), a local operator can check the pertinent information relative to the container(s) which is shown on a video display. This information is also available to the terminal operator via video display and/or a printed copy.

In export Module B, the input of a complete loading record from CCIRS may assist in performing the final check of the cargo loading. This information is required for Module C to prepare the Final Manifest.

(2) **Import Process Cycle.** We assume the application of CCIRS in the Import Process Cycle in a scenario of port systems in operation at USAREUR. The operation of import is similar to the reverse order of the export process. The applications of CCIRS are suggested in the following areas:

● At the shore for the cargo-discharge process from the vessel. The CCIRS can be applied at the shore to record containerized cargo during the discharging process from the vessel. The system also can be set at marshaling areas for import cargos. The data also can be transmitted to the DASPS import process. Comparison of records of the two systems can provide the following information:

● During the discharging process, the CCIRS can reveal the real-time data of cargo status of the unloading process. This information can assist shore operation to make an accurate projection time and effort required to complete the unloading process.

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● The CCIRS can assist to trace a container during the unloading process.

● Upon completion of the vessel discharging, the agreement between the records of CCIRS and DASPS is solid evidence of correctness. If there is any difference,the responsible person is notified.

● The CCIRS can assist the DASPS import process in preparing the Weekly TCMD accountability report and port balance report.

d. **Application of CCIRS in HFM.** The CCIRS can be used best in the HFM system to provide real-time monitoring of the commitments and transportation equipments status of the 4th Transportation Brigade. The following are locations in which CCIRS could produce the greatest benefit to enhance the HFM capabilities:

(1) **Location of the Customer's Area.** HFM customers are POE, POD, APOE, APOD, and consignee areas. The timing and accuracy of data on the commitments status and the utilization of the transportation assets are essential to the successful operation of HFM. The following information can be transmitted to the local TMO's in real-time or in an edited form: the I.D. code of each trailer and its status; the I.D. code of its associated container, if any, and the time of arrival or departure at the customer area.

All customers within a TMO area of responsibility submit data as to the status of commitments and trailers at their locations. The TMO consolidates these reports and submits the DISR to group operations via Telex. The DISR indicates the customer unit designator, number and city, commitment reference number, trailer number, status, and required delivery date.

(2) **Trailer Transfer Point.** There are seven TTPs which serve as central control points for all trailer/tractor movement. They are assigned to the 37th Transportation Group and are under the operational control of the battalions. The application of CCIRS could assist TTP in the following operations:

(a) Performs trailer checks.

(b) Performs yard checks: A list of all trailers which are located at TTP, the status of the trailer, the reference number, and the required delivery date if applicable.

(c) Performs connecting link between line-haul operations and local pull/delivery.

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(d) Performs control for group vehicles (tracks, tractors, and trailers) operating in the TTP area of responsibility.

The information collected and edited by the CCIRS will be used for the preparation of the following documents:

- **Yards Checks.** This report is prepared daily by the trailer transfer points. It includes a listing of all trailers which are located at the TTP, the status of the trailer, the reference number, and the required delivery date if applicable. Each TTP is attached to one of the battalions and submits its yard check through the Battalion Headquarters to the Group. Also submitted, both by TTPs and major Depot Liaison Sections are TMSLs reflecting the daily intransit status of all trailers moving through the TTP or major Depot Liaison Section, respectively. Yard checks should arrive at Group no later than 2100 hours.

- **Trailer Movement Status Logs.** These logs also are submitted by the TTP and Major Depot Liaison Sections. The logs reflect the flow of trailers through the TTP or major depot and must also arrive at the Group no later than 2100 hours.

At the present time, there is no intention to change the system documentation procedure and structure by application of CCIRS. However, there is a potential benefit to eliminate some unnecessary documentation by direct transmission of real-time information to the Battalion or Group. The information can be organized and edited into files instead of hard-copy documents from lower level.

e. **Application in VIC.** VIC is a system concerned with cargo on movement while the HFM is a system concerned with the transportation resource for highway use. For every cargo moving on highway, both VIC and HFM will be kept informed although their function and responsibilities are different.

VIC's master files are updated by information received from WPOD, APOD, AATCO, area MSC office, commercial SEAVAN carriers, TMO's, and theater transportation command/group(s) or their subordinate units. Information from all of these sources can be categorized into the following two classes:

(1) **Direct Information.** Information on container cargo movements is transmitted to the VIC center by parties directly in contact with the cargo. These locations are WPOD, APOD, TTP, TSP, and consignee's areas. An adequate setup of CCIRS in these areas could contribute the real-time information to the VIC.

(2) **Indirect Information.** Information is transmitted to VIC center from a source that gathers from other sources. This secondhand information is edited from information gathered by the persons where CCIRS may be used. Indirect information is sent to VIC by HFM, DASPS, TMO, AATCO, and MSC. The potential benefits that CCIRS may contribute to the VIC are as follows:

- Provide and maintain accurate and real-time information.

- Assist VIC to reconsign, direct, hold, expedite, locate, and cancel cargo and maintain visibility during these operations.

- Assist consignee receiving cargos and reporting the cargo arrivals.

13. Technical Requirements. In this paragraph, the technical requirements for the range of the interrogator and buffer capacity of the terminal device will be discussed for operation of a CCIRS in the areas within DTS where high density of cargo movement usually occurs.

a. **Range.** There are three operational modes: gate, mobile, and line-of-side. The gate and line-of-side modes are operated for monitoring the moving traffic and cargos. The mobile mode, in general, is used to record the stationary cargo and its transport equipments.

(1) **Gate Mode.** The gate, in a broad sense, is an opening or boundary for entrance/exit. It could be a formal gate, an area with temporary setting for entrance/exit, or a section of access/egress road designated for gate purposes. The gate mode of operation can be applied at the entrance/exit of a depot, marshaling area, TTP, TSP, POD, POE, or consignee areas. The widths of the entrance/exit and the access/egress roads are about in the range of 15 to 50 feet with two-way traffic. The interrogator can be placed about 5 to 10 feet away from the boundary of the road. Therefore, a 30-foot range is considered adequate to cover most occasions in the gate operation.

(2) **Mobile Mode.** The mobile mode is applied in the marshaling areas, TTP, depot, TSP, consignee areas, and places where the container and transport equipments are stationary and line up in an orderly manner. Containers may be placed in a marshaling yard either on-chassis or stacked off-chassis. Many commercial operators use the on-chassis method of stacking containers.[28] The pattern of on-chassis and

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[28] US Department of Army, *Container Operations*, TC 55-5 (October 1977).

off-chassis stacking is shown in Figure 20. It can be seen that patterns A and B of the on-chassis configurations are not easy for the mobile mode operation if the container has only one label mounted on the long side of the container. For the off-chassis stacking, containers not placed along the edge of the stacking block will not be reached easily by the interrogator. The ribbon stacking pattern is considered to be the best configuration for the mobile mode operation. However, if only one label is mounted on the container caution must be taken during the container stacking process that the side with the label should always face the aisle. This situation could be improved with an extra sign on the container or two labels on each side of the container. Two labels for each container will increase expenditure considerably on capital equipment.

The width of aisle on spacing between the stacking depends on the size of the container and the characteristics of the container-handling equipment. For a sideloader, the recommended minimum operating space is a 15-foot working aisle and a 50-foot intersecting (turning) aisle. For a frontloader carrying a 20-foot container in a 90-degree stacking operation, the frontloader has a 45-foot turning radius; carrying a 35-foot container, a 52-foot turning radius; and carrying a 40-foot container, a 65-foot turning radius. The information on stacking and aisle width is shown in Figure 21.[29] With the above data, the range requirement for the interrogator at mobile operation can be adequately set at 35 feet if we assume that it operates at the center of the aisle. The range equipment can be reduced considerably to about 20 feet if the operating distance is set within 20 feet of the stacking.

(3) **Line-of-side.** This mode, in general, is operated along the highway to monitor the cargo movement, the traffic pattern, and the cargo-distribution patterns. The range requirement for this operation depends on the size of the highway. The standard lane width of a highway is about 12 feet; in many cases, it could range from 8 feet to 15 feet. Assume that the interrogator is placed about 10 feet away from the boundary of the highway; then, the range requirement can be written as:

$$R = 16 + 12 (N - 1)$$

where N is the number of lanes of one-way traffic. For an 8-lane superhighway (4 lanes each way), the range requirement is about 52 feet.

For the case of a multiple-lane highway, the label always has a chance to be blocked by the same-direction traffic between the interrogator and the labeled vehicles unless the labeled vehicle travels on the outside by the shoulder.

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[29] *Container Operations* (Washington, D.C.: Headquarters Department of Army, 1977), pp 7-18.

PATTERN B

ASPHALT

CONCRETE STRIP

PATTERN A
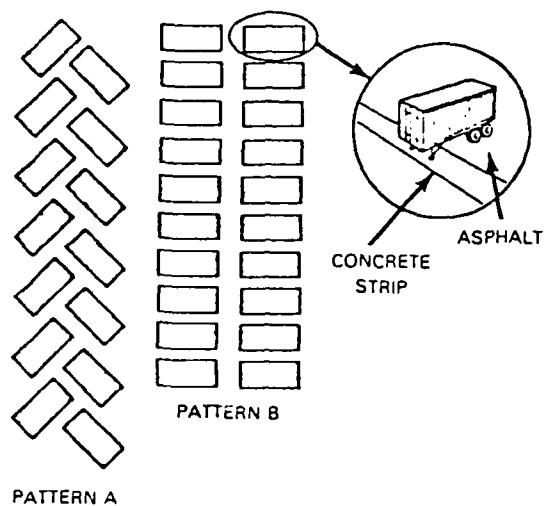
Container on-chassis configuration

TOP VIEW

ONE CONTAINER HIGH
TWO CONTAINERS HIGH

SIDE VIEW

TURRET STACKING

RIBBON STACKING   BLOCK STACKING
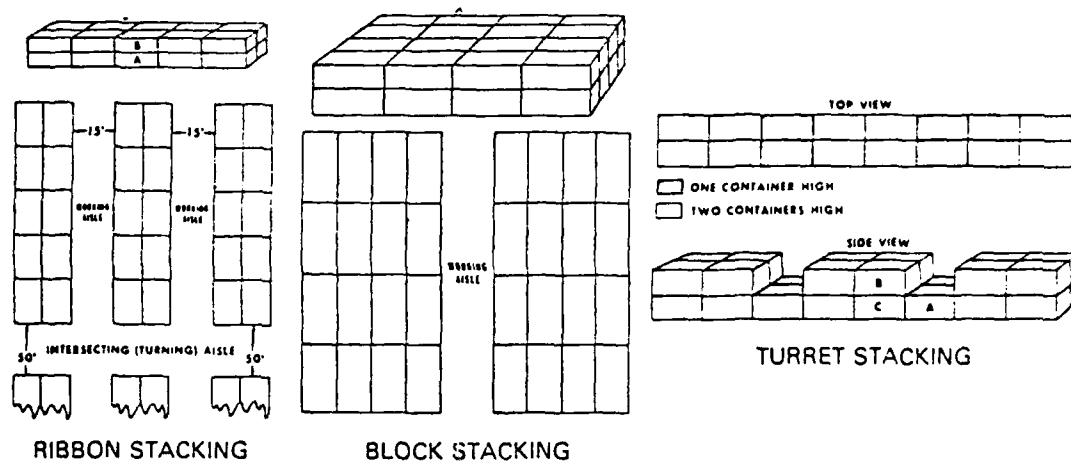
Primary off-chassis stacking configurations

Figure 20. Container on-chassis and off-chassis stacking configurations.

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Working with 40-foot containers, the sideloader requires a minimum working space of 15-foot working aisle and 50-foot intersecting (turning) aisle.
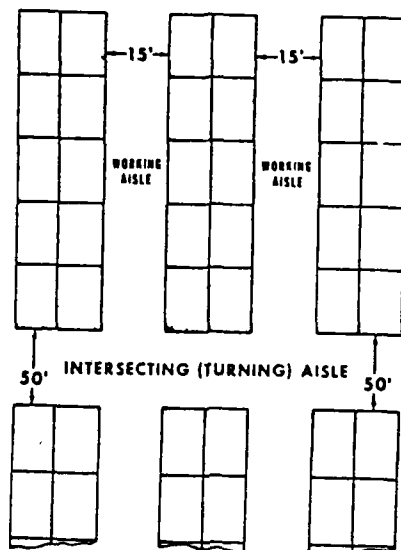
Working the marshaling area, the front loader requires a minimum working space of:

O For the 20-footer, 50' working aisle, 50' intersecting aisle.

O For the 40-footer, 70' working aisle, 70' intersecting aisle.
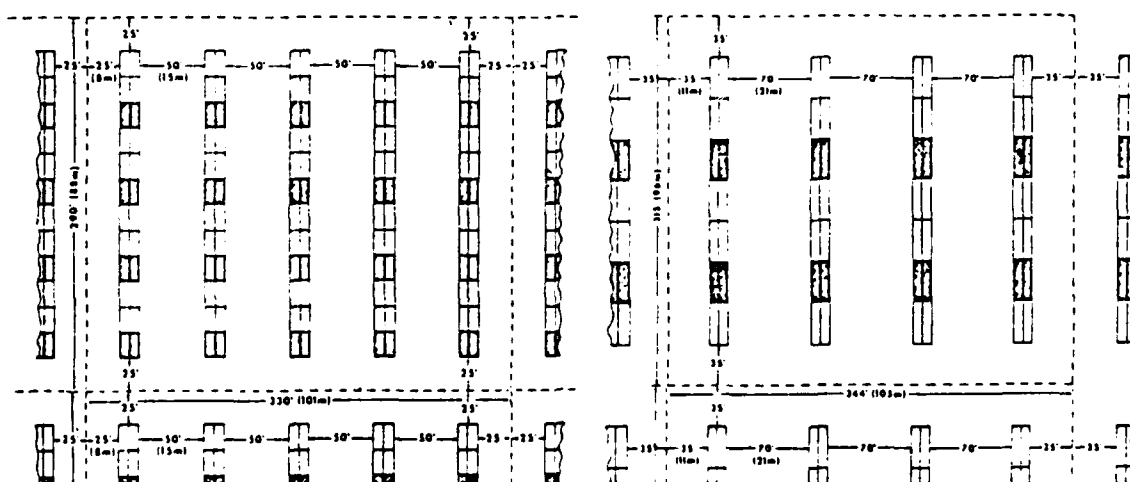
Figure 21. Working-aisle configuration for off-chassis stackings.

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The probability (P_f) of the interrogator failing to complete the scanning because of the traffic blocking is analyzed in the following paragraph. The results are computed and plotted in terms of speed and traffic densities. This analysis is based on a constant speed of traffic, average car length, and average spacing between any two moving consecutive cars. For a high accuracy data requirement, the line-of-side mode is not recommended for a busy, multiple-lane highway unless an enforcement that ensures the traffic to be monitored travels on the outside lane by the shoulder at the time and place the interrogation is taking place.

b. **Probability of Failure Because of Traffic Blocking the Interrogator.** There is always a chance that the interrogation of the line-of-side mode cannot be successfully operated because the traffic blocks the line-of-sight between the label and the interrogator on an open, multiple-lane highway. The probability of failure to complete the interrogation (P_f) will be analyzed as follows:

Notations:

P_b = Probability of the line-of-sight being blocked by moving vehicle.

P_s = Probability of the line-of-sight not being blocked by a moving vehicle.

P_f = Probability of failure to complete the interrogation.

d = Traffic density (number of cars/h/lane).

S = Traffic speed (mi/h or ft/s).

S_ℓ = Speed of the labeled vehicle (mi/h or ft/s).

ℓ_α = Average distance between two consecutive vehicles (ft).

ℓ_ν = Average length of the vehicle (ft).

ℓ_ℓ = Length of the label (ft).

t = Time required to complete the scanning for one label (s).

Assume the traffic moves uniformly and keeps a constant speed (S). Also assume the line-of-sight is completely blocked whenever there is a vehicle between the label and the interrogator.

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For a simple case, the label is considered as a single point. At a certain instant, the probability of a vehicle blocking the line-of-sight between the label and the interrogator is

$$P_b = \ell_\nu/(\ell_\nu + \ell_\alpha).$$

Considering the physical size (ℓ_ϱ) of the label, the probability of a vehicle blocking any part of the label can be written as

$$P_b = (\ell_\nu + \ell_\varrho)/(\ell_\nu + \ell_\alpha).$$

The interrogator requires a certain time (t) to complete the scanning of the label. During the time (t), the moving traffic, which has the relative speed $|S-S_\varrho|$ with respect to the labeled vehicle, has an increasing probability of blocking the line-of-sight of interrogation, that is:

$$P_b = (\ell_\nu + \ell_\varrho + t\ |S - S_\varrho|)\ /\ (\ell_\nu + \ell_\alpha).$$

The typical value for (t) is less than 6×10^{-3} which is evaluated by the time required to read the label three times (originally designated for the interrogation process). Each label is coded by 72 bits for 4 letter and 8 numerical characters. For each interrogation, t is required to read $3 \times 72 = 216$ bits. The data rate of the interrogation is 42000/s, therefore,

$$t = 216/42,000 = 5.4 \times 10^{-3} \text{s}.$$

assume:

$$|S-S_\varrho| = 10 \text{ mi/h} \simeq 14.7 \text{ ft/s}$$

and

$$t\ |S-S_\varrho| \simeq 7.56 \times 10^{-2} \text{ ft}$$

which is less than an inch in length. It is negligible in comparison with the vehicle length in the computation of P_b. The length of the label ℓ_ϱ is about 0.3 ft. The error introduced by neglecting ℓ_ϱ in computation of P_b is probably smaller than that introduced by estimation of the average vehicle length. Based on the above reasoning, the probability, P_b, can remain in the simplest form, that is:

$$P_b = \ell_\nu/(\ell_\alpha + \ell_\alpha \ell_\nu).$$

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For a multiple-lane highway, the probability, P_s, that the label will not be blocked by the next-lane traffic is:

$$P_s = 1 - P_b.$$

The probability, P_s, that the label will not be blocked by the next-two-lane traffic is:

$$P_s = (1 - P_{b1})(1 - P_{b2}).$$

For n lanes, P_s is:

$$P_s = (1 - P_{b1})(1 - P_{b2}) \ldots \ldots (1 - P_{bn}).$$

The probability, P_f, that the interrogation cannot be completed because the label could be blocked by any traffic on the next n lanes can be written as:

$$P_f = 1 - P_s = 1 - (1 - P_{b1})(1 - P_{b2}) \ldots \ldots (1 - P_{bn}).$$

For an ordinary 4-lane highway (2-lane each way):

$$P_f = P_b.$$

A typical, multiple-lane-highway traffic pattern during a 24-hour observation consists of about 80 percent of ordinary passenger cars and 20 percent of small and large trucks, trailers, and buses. (Data were supplied by the Virginia Highway Department on Interstates 95 and 495 around the metropolitan area of Washington, D.C. Assume the average passenger car length is 16 ft; the average truck, trailer, and bus length is 30 ft; and the average length of all vehicles is about 19 ft.

Table 1 is the computer result of P_f for 4-lane, 6-lane, and 8-lane highways (2-lane, 3-lane, and 4-lane each way) for traffic speed S=60 mi/h, 50 mi/h, 40 mi/h, and 30 mi/h at various traffic densities (d) defined by the average number of vehicles over a number of lanes of the one-way traffic passing through one point in one hour. These results are also plotted in Figure 22. These results are based on the assumption that the labeled vehicle travels at the center lane of the highway. For a 4-lane highway, P_f is linearly proportional to d. For a 6-lane and wider highway, the probability P_f is no longer a linear relation with d.

In many practical cases, the locations of labels on a truck and a container may be higher than an ordinary passenger car. During the line-side-mode operation, the ordinary passenger car may not be an obstruction to the interrogation if the antenna of the interrogator is set above the height of an ordinary passenger car.

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Table 1. Probability of Failure (P_f) to Complete
the Interrogation on a Multiple-lane Highway

P_f for 4-lane highway (2-lane each way)				
S \ d	d=1000	500	300	100
S=60 mi/h	5.93%	2.97%	1.78%	0.593%
50	7.12%	3.56%	2.14%	0.712%
40	8.90%	4.45%	2.67%	0.890%
30	11.87%	5.93%	3.56%	1.19%

P_f for 6-lane highway (3-lane each way)				
S \ d	d=1000	500	300	100
S=60 mi/h	11.5%	5.85%	3.53%	1.18%
50	13.7%	6.99%	4.23%	1.42%
40	17.0%	8.70%	5.27%	1.77%
30	22.3%	11.5%	6.99%	2.37%

P_f for 8-lane highway (4-lane each way)				
S \ d	d=1000	500	300	100
S=60 mi/h	16.8%	8.65%	5.25%	1.77%
50	19.9%	10.3%	6.27%	2.12%
40	24.4%	12.8%	7.80%	2.65%
30	31.6%	16.8%	10.2%	3.53%
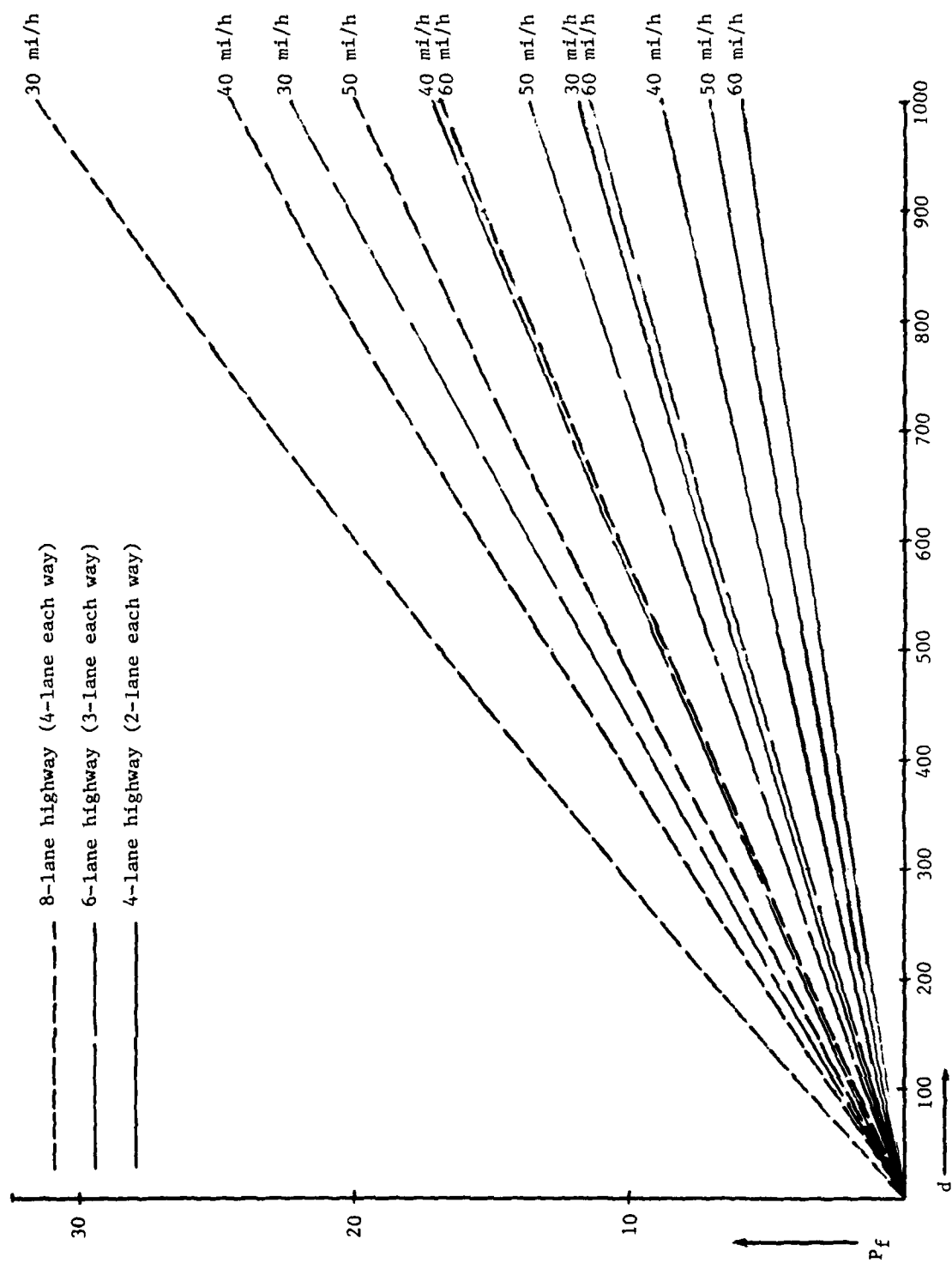
Figure 22. Probability of failure (P_f) to complete the interrogation on a multiple-lane highway.

8-lane highway (4-lane each way)

6-lane highway (3-lane each way)

4-lane highway (2-lane each way)

30 mi/h

40 mi/h
30 mi/h
50 mi/h
40 mi/h
60 mi/h

50 mi/h
30 mi/h
60 mi/h
40 mi/h
50 mi/h
60 mi/h

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The obstruction of the line-of-sight from the traffic would be from the large vehicles only – buses and trucks – which includes about 20 percent of all highway traffic based on a 24-hour observation. Assume the average length of the large vehicles is 30 feet and the vehicle is travelling at a constant speed. The probability that the interrogation cannot be completed because of the obstruction of the large vehicles is computed in terms of traffic speed and truck traffic densities, and the results are shown in Table 2 for 4-lane, 6-lane, and 8-lane highways (2-lane, 3-lane, and 4-lane, each way). The results are also plotted in Figure 23. The truck-traffic density above 500 probably happens rarely. At a certain key traffic point, however, the truck traffic could be heavy, and, in general, the truck-traffic density is higher around industry-concentrated areas and dense population areas. The truck-traffic pattern usually is not distributed uniformly among the entire traffic pattern and varies from day to night. For a short-time run, it could produce a substantial difference between the computed prediction and the experimental value, P_f.

For each moving unit the container, and its associated truck and chassis, three labels, one for each, will likely be used. During the interrogation, there could be the case where all three units cannot be interrogated because of traffic blocking. Assume a successful operation is defined on completion of interrogation of all three labels, and let P_{3f} be the probability of failure when any part of the three labels is blocked during the interrogation. In this case, the probability, P_{3f}, is higher than the case of a single label and also a function of the spacing between labels in a moving unit.

(1) The horizontal spacing between any two labels is larger than ℓ_v, the average vehicle length. In this case, the probability, P_{3f}, for three labels is the summation of the three individual P_f's of each label, that is:

$$P_{3f} = P_b + (1 - P_b) P_b + (1 - P_b)^2 P_b .$$

On the right side of the equation, the first term is the probability that the first label is blocked by the traffic; the second term is the probability that the second label is blocked provided the first label is unblocked; and the third term is the probability that the third label is blocked by the traffic provided the first and second labels are unblocked. P_{3f} can be simplified as:

$$P_{3f} = 1 - (1 - P_b)^3 .$$

Similarly, for n labels:

$$P_{nf} = 1 - (1 - P_b)^n .$$

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Table 2. Probability of Failure to Complete
Interrogation Because of Obstructions of Large Vehicles

P_f for 4-lane highway (2-lane each way)						
s \ d	500	300	200	100	50	20
60 mi/h	4.73%	2.84%	1.89%	0.947%	0.473%	0.189%
50	5.68%	3.41%	2.27%	1.14%	0.568%	0.227%
40	7.10%	4.26%	2.84%	1.42%	0.710%	0.284%
30	9.47%	5.68%	3.79%	1.89%	0.947%	0.379%

P_f for 6-lane highway (3-lane each way)						
s \ d	500	300	200	100	50	20
60 mi/h	9.24%	5.60%	3.74%	1.89%	0.944%	0.378%
50	11.0%	6.70%	4.49%	2.27%	1.13%	0.533%
40	13.7%	8.34%	5.60%	2.82%	1.41%	0.567%
30	18.0%	11.0%	7.44%	3.74%	1.89%	0.757%

P_f for 8-lane highway (4-lane each way)						
s \ d	500	300	200	100	50	20
60 mi/h	13.5%	8.28%	5.56%	2.81%	1.41%	0.566%
50	16.1%	9.88%	6.66%	3.38%	1.69%	0.679%
40	19.8%	12.2%	8.28%	4.20%	2.11%	0.850%
30	25.8%	16.1%	10.9%	5.56%	2.81%	1.13%
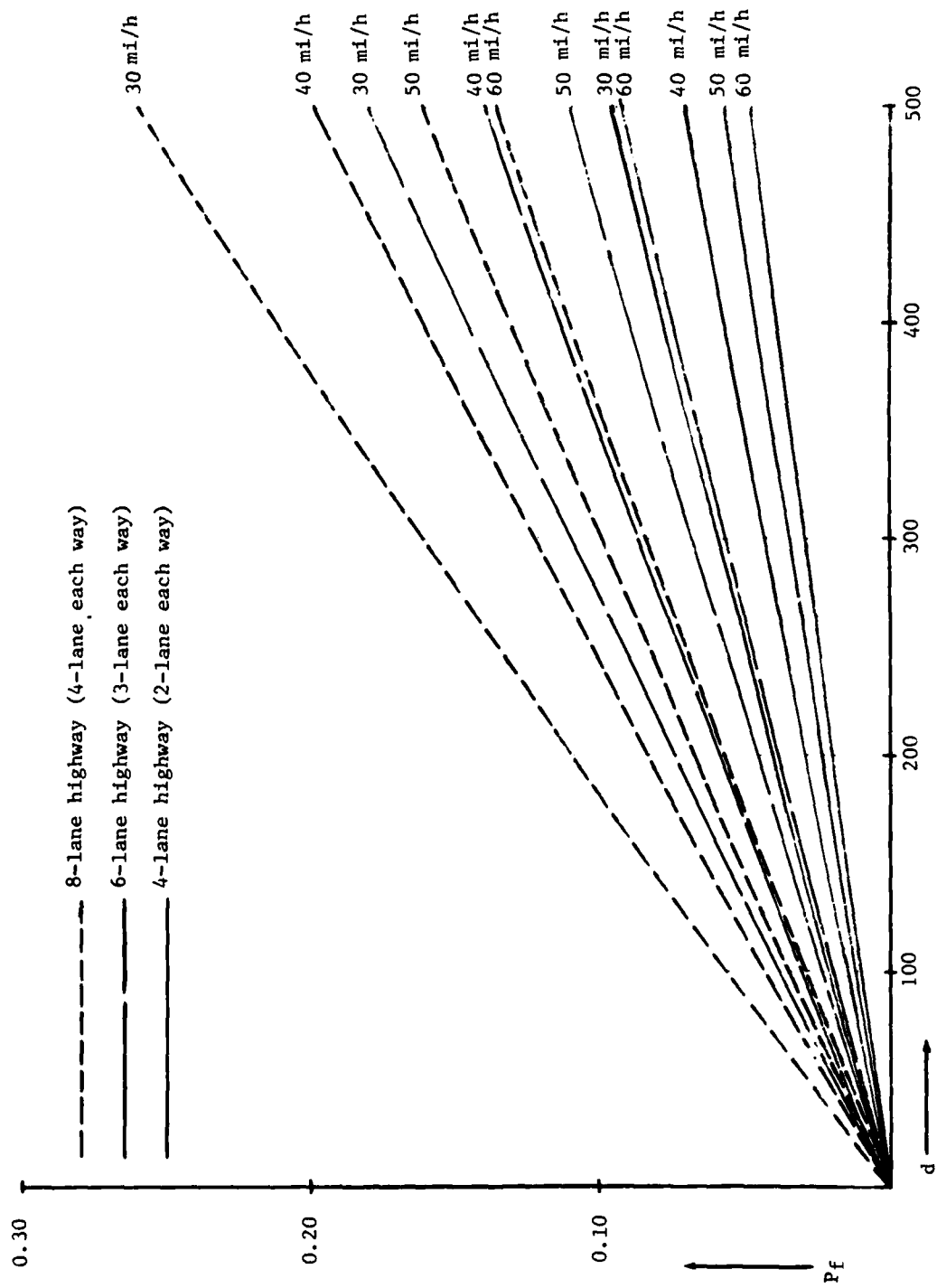
Figure 23. Probability of failure (P_f) to complete the interrogation of obstruction of large vehicles.

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(2) The horizontal spacing between any two consecutive labels is smaller than ℓ_ν. In this case, whenever one label is blocked by the traffic, there is always the chance that the second or even the third label is blocked by the same vehicle. To compute the probability, P_{3f}, we can assume the three labels as one label with the label length, $\ell_{3\varrho}$ which is equal to the horizontal as indicated in the following:

Label   Label   Label
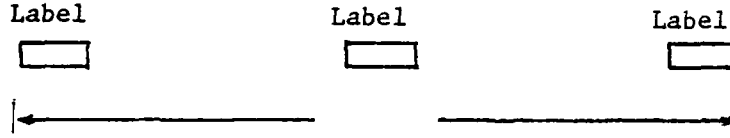
The probability, P_{3f}, can be formulated as:

$$P_{3f} = (\ell_\nu + \ell_{3\varrho})/(\ell_\nu + \ell_\alpha)$$

for every $\ell_{3\varrho} < \ell_\alpha$, and

$$P_{3f} = 1$$

for every $\ell_{3\varrho} \geqslant \ell_\alpha$.

(3) The horizontal spacing between two consecutive labels is smaller than ℓ_ν, and the horizontal spacing between the third label and its closest label is larger than $\ell_{3\varrho}$. In this case the two close labels can be considered as one label with label length, $\ell_{3\varrho}$, defined as the distance of two labels similarly as $\ell_{3\varrho}$ described in (2). The probability, P_{2f}, according to (2) that any part of the two close labels could be blocked is:

$$P_{2f} = (\ell_\nu + \ell_{2\varrho})/(\ell_\nu + \ell_\alpha).$$

The probability, P_{3f}, that any part of the three labels could be blocked can be written, according to (1), as the combination of P_f for a single label and P_{2f} from the above equation:

$$P_{3f} = P_h + (1 - P_h)(\ell_\nu + \ell_{2\varrho})/(\ell_\nu + \ell_\alpha)$$

for every $\ell_{2\varrho} < \ell_\alpha$, and

$$P_{3f} = 1$$

for every $\ell_{2\varrho} \geqslant \ell_\alpha$.

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The numerical plot of P_{3f} has not been carried out at the present time because of a lack of suitable values for distances among labels. These formulations can provide an instant estimation of the probability, P_{3f}, whenever the data elements are available.

c. Storage Capacity of Buffer.

(1) For the Moving, Containerized Cargo and its Transport Equipment. The label is coded by 4 letters and 8 numerical characters. Each letter and each numerical character is coded by 8 bits according to ASC codings. For each label, the interrogation adds another 4 numerical characters to indicate the time the code was accepted. Therefore, for each label there are 128 bits that the interrogation transmits to the data buffer or the terminal device. For each container and its associated truck and chassis, 3 labels may be needed — one label for each. In other words, a capacity of 384 bits may be required in the buffer for each unit of the moving, containerized cargo. Assume that at one time, the interrogation is required to record 1000 vehicles with containers. The buffer capacity for the above case in about 3.84×10^5 bits. In most cases, the buffer capacity for 1000 vehicles is more than we need for the line-side mode or gate-mode operations. For demonstration purposes in a convoy at a speed of 55 mi/h and during a 30-min period, there will be 631 trucks passing an interrogation point. The above computation assumes that vehicle length is 30 feet and there is 200 feet following distance between vehicles. The truck-following distance is required by the State of Virginia, and data were afforded by the Virginia Highway Department.

(2) For Stationary Containers. For the case of the stacked containers, one label for each container, that is, 96 bits, is required for buffer capacity. For the stationary container, 4 numerical characters to indicate time may not be necessary. Sometimes, there are a small number of containers in the marshaling area placed on-chassis. In this case, two labels (extra label for the chassis) may be required, that is, 192 bits for each unit. The size of the marshaling areas of some ports is fairly large; for example, the marshaling area of Nordhafen and Stromkaje (they are linked together) has 741,000 m² which is about ¾ square kilometer or 183 acres. It has a stacking capacity of nine 300x20-ft containers in the first layer; sixteen 600x20-ft containers in two layers. Assume at peak time that the marshaling area is stocked at its full capacity and also assume that at one time 50 percent of the stacked containers require interrogation at mobile mode operation. The capacity of the data buffer under the above conditions is about 9×10^5 bits. Conditions on computating the above buffer capacity are purely arbitrary without any adequate field observation and field operation data.

14. RAM Analysis. The reliability analysis deals with the two items in the CCIRS which are subject to severe operating conditions, the label and interrogator. The remaining items which are part of this system are indoor electronic hardware, largely commercial off-the-shelf equipment, with well-defined reliability and maintainability characteristics.

The label's reliability requirements must be consistent with its mode of use. It must be able to endure long periods in the harsh environment of a cargo container. It will be subjected to a variety of temperature extremes as the container is shipped to various climatic zones. It will experience shock and vibration commensurate to rough material-handling operations as well as rail and truck transport. However, the label will operate for only a few milliseconds a year for its service life of 8 years.

Because of these operating conditions, an accelerated life test should be designed which can present the temperature extremes, salt-water exposure, shock, and vibration in a relatively short time. The test should simulate the number of ocean voyages, rail movements, truck movements, and material-handling operations determined to be realistic in the life of a cargo container. Shock and vibration conditions can be determined from test for the various temperature means. Temperature cycling can be determined from conditions known to exist along shipping routes. The number of cycles of each type of treatment can be determined on the basis of the number of moves commonly encountered during service life. The label should be operated infrequently to represent actual service as near as possible and only then to verify proper functioning. Such a test is straightforward to design and is not attempted in detail here.

The interrogator's mode of use is primarily a roadside environment generally in a fixed location for the life of the device. Although some interrogators will be mounted on vehicles and have to approach in a mobile mode. As with the label, the interrogator will spend the majority of its service life in a low-power standby mode with relatively short periods of operation. Experience gained thus far indicates the interrogator either will work well, with high accuracy, or will not work. Therefore, the analysis which follows is centered on its availability character. After deriving likely ranges for availability and taking into account time requirements for maintenance, the necessary reliability ranges are established. Once these requirements have been selected, selection of standby reliability test is straightforward and a reasonable example has been set forth.

The potential RAM characteristics required for the interrogator should be based on the following factors:

● Overall accuracy of the system in which the interrogator is used must not be degraded by interrogator downtime. To achieve this result, the apparent availability of the interrogator must be relatively larger than its identification accuracy rate of 99 percent.

● Since the interrogators normally will be operated unattended, their availability must take into account the time required for discovery of a failure and the time required for a repairman to arrive at the interrogator site as well as the mean-time-to-repair. Another important factor is the repairman having the correct parts when he arrives at the interrogators site.

● The interrogator reliability must allow achievement of the availability and total time to return service requirements as well as be technically reliable and provable in a test program commensurate with the development effort.

The foregoing factors are critical to the ability of the interrogators to achieve a high identification accuracy rate as a part of information system with automatic, source-data acquisition. In addition, the design of the interrogators must account for the maintenance burden imposed on using units in terms of manhours required and on the logistics system in terms of support costs.

The prominent design feature of the interrogator which becomes manifest from the foregoing is the capability of an interrogator to report its own failure and thus allow the repair process to commence. This can be accomplished readily by incorporation of appropriate software into the onboard microprocessor in addition to circuits in each major subassembly which can be exercised periodically and the status reported over the channel which normally outputs label data. An important aspect of this automatic, self-checking capability is that the interrogator reports the nature of the failure so that the necessary parts for a rapid repair can be brought with the repairman.

A second design feature which is essential in the practical implementation of the automatic, self-checking concept is that the interrogator be composed of a relatively small number of rapidly replaceable modules. The modular design makes the reporting of the failed part and the repairman's bringing the replacement part a practical possibility by limiting the types of failures and the number of repair parts present in the using unit to manageable quantities. Each module can be designed to be replaced with common tools such as a screwdriver and a small wrench. The design of checking circuits is also facilitated by limiting them to a few designated modules. Each checking circuit would be a part of the module checked and would he replaced along with the module if, in fact, it was the checking circuit that failed. Failure

of the microprocessor, the ultimate checking circuit, as well as outright power failure can be monitored readily by periodic communication checks with the central data-accumulation point.

The rapid discovery and repair of interrogator failures notwithstanding, the components used in the interrogator must be of relatively high quality to reduce the maintenance burden. The maintenance burden can be divided into two principal categories. The first category is field effort expressed as the using unit and direct-support unit manhours. This effort is proportional to the required availability. The second category is logistic support which is best expressed as the cost of general and depot maintenance. It is generally proportional to the failure rate of the hardware.

Thus, availability becomes the key factor in selection of quantitative RAM characteristics for the interrogator. Next, the field application can be examined for a realistic range of time required to restore the equipment to service, bearing in mind that the actual repair time must be made a relatively minor factor by the hardware design. With these values established, a range of suitable MTBFs can be calculated and assessed in terms of technical feasibility and cost.

This logic can be used to establish baseline numeric values for the RAM characteristic which will be representative of the actual requirement. The values developed can be optimized for various desired characteristics, and a reasonable trade-off can be accomplished during user-developer joint working group meetings.

The starting point is the availability requirement. Since the RAM characteristics must be harmonious with the identification accuracy rate of the interrogator and can allow only a small contribution to data loss, the value selected must be small in comparison to the 1 percent error rate allowed. To get a feel for viable numbers, the basic definition of availability must be examined. For the purpose of this discussion, availability can be defined as follows:

$$A = \frac{\theta}{\theta + R} \tag{1}$$

where: θ = meantime-between-failure, a hardware parameter equal to the total time of operation divided by the number of independent failures.

R = Restoration time, the amount of time taken to restore a failed interrogator to service including time to discover the failure, travel time to the interrogator, and actual time to effect the repair.

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Examining this relationship we can show that for a given availability (A), the MTBF (θ) required becomes a function of the restoration time possible:

$$\theta = \frac{A}{1-A} \, R. \tag{2}$$

So it becomes obvious that the required θ can be calculated readily based on restoration time if A is fixed by the requirements of the mission. Finally, we can examine some values of A to see the effect on the ratio between θ and R, i.e.:

$$\frac{\theta}{R} = \frac{A}{1-A} \tag{3}$$

Equation (3) is plotted in Figure 24 for likely values of A. The most interesting range of θ/R occurs between A = .9975 and A = 0.9985. This range of values will allow interrogator failures to account for 15 to 25 percent of the allowable 1 percent error.

Proceeding to the restoration time, R, it is possible to assume a short interval, say 5 to 15 minutes, between interrogator failure and discovery since the onboard microprocessor can report module failure. The actual mean-time-to- repair an interrogator on site by module replacement can also be made relatively short, say 15 to 25 minutes, by well-defined design techniques. So it is reasonable to allow 0.5 hour for both activities. The bulk of the restoration time will then be composed of travel time to the interrogator site. The actual repair of the interrogator by module replacement can be undertaken readily by one of the personnel normally present at the local transportation-management activity with only a screwdriver and, perhaps, a wrench. Presuming an average vehicle speed of 20 mi/h, it is possible to compute some typical travel times for several likely distances between local control centers and interrogator sites:

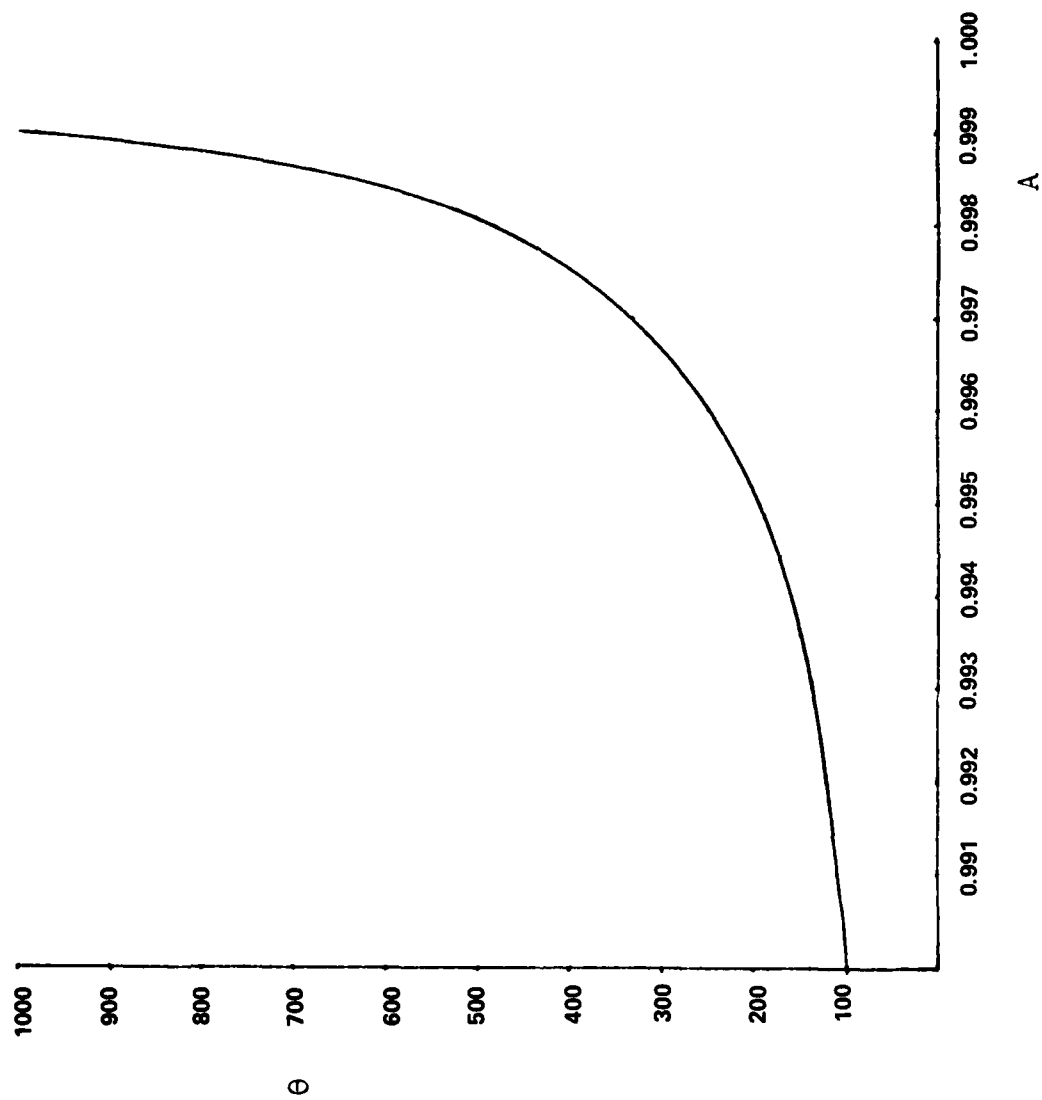| Distance	Travel Time	Restoration Time
d	$t = \dfrac{d}{20 \text{ mi/h}}$	$R = t + 0.5$ hour
(miles)	(hours)	(hours)
0	0.000	0.50
5	0.25	0.75
10	0.50	1.00
30	1.50	2.00
50	2.50	3.00

Figure 24. Plot of $\dfrac{R}{\theta} = \dfrac{A}{1-A}$ for values of A in the acceptable range.

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Computing θ for the overall extremes thus far considered, the minimum case is:

A = 0.9975.

R = 0.5 hour

$$\theta = \frac{0.9975}{1 - 0.9975} \times 0.5 = 200 \text{ hours.}$$

This implies that an interrogator with an MTBF of only 200 hours would be workable if it were located in the immediate vicinity of a control site with a supply of repair modules.

The maximum case yields:

A = 0.9985.

R = 3 hours.

$$\theta = \frac{0.9985}{1 - 0.9985} \times 3 = 1997.$$

This result indicates an MTBF of 2000 hours would be required for an interrogator 50 miles away with an excellent availability factor.

The above calculations establish the general range of the minimum acceptable MTBF; that is, the MTBFs necessary for acceptable system operation. However, since interrogators will often be located some distance from a control center, a somewhat larger MTBF than the 200 hours would be desirable. MTBFs in the range of 200 to 2000 hours are considered quite feasible, but there are presently insufficient data to make an accurate assessment of the effect of design costs for MTBFs in this range.

It is possible, however, to estimate maintenance costs roughly. The number of user and direct-support manhours involved in repair actions can be established on a comparative basis since they will be proportional to the number of failures per year and the manhours involved in each repair. For a given MTBF, the number of failures per year is equal to the failure rate or $1/\theta$ times the number of hours in a year, 8760. The manhours required to effect repairs will be proportional to the restoration time. For this analysis, the number of manhours to restore an interrogator is estimated to be double the restoration time. This is based on the fact that most of the restoration time is travel time, and the repairman must return to his original location after the repairs are made. Therefore, these manhours can be computed using the following formula:

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$$MH = \frac{8760}{\theta} \times 2 \times R$$

$$MH = 17520 \frac{R}{\theta} \ . \tag{4}$$

The manhour figures obtained from equation (4) can be converted to cost by applying the annual salary of an SP4 with typical overhead factors, $11,950, divided by 2080, the number of manhours in a 40-hour workweek year. This will provide a conservative estimate since, in general, uniformed military personnel can work more than 40 hours if necessary.

The cost to repair a module is estimated to be approximately $500 taking into account investment in spares; $1500/module, which can be repaired 10 times; repair manhours, 8 mh @ $30 per mh; transportation, $20; repair components, $40; and $50 miscellaneous overhead and management. If not precise for a given maintenance action, this figure is highly representative. The annual support maintenance cost for an interrogator can then be calculated as:

$$Cost = \frac{8760}{\theta} \times \$500. \tag{5}$$

Maintenance costs for various values of θ and R using equations (4) and (5) are tabulated in Table 3.

Examination of Table 3 results in the conclusion that an interrogator with a 200-hour MTBF would be obnoxious to the user to keep in service unless it was located within a few hundred yards of a repair site. Even then, the cost of repair modules would be almost prohibitive. Few interrogators this low on MTBF could be tolerated even though, in theory, it could accomplish the mission within a 10-mile radius of the repair station.

Interrogators with MTBFs in the 1000- to 2000-hour range readily accomplish the mission. An interrogator with a 1000-hour MTBF and 50 miles from the repair point could prove troublesome, but the overall maintenance cost is less than half of the 400-hour MTBF unit, so the 1000-hour unit suggests itself as a possible minimum acceptable MTBF.

Table 3. Maintenance Costs for Various Values of θ and R.

MTBF θ	Restoration Time R	Availability $A = \dfrac{\theta}{\theta+R}$	Field M/H Eq (4)	M/H Cost $X \dfrac{11950}{2080}$	Sup Cost Eq (5)	Total Cost Per Intg. Per Year
200	0.5	.9975	43.8	252	21,900	22,152
200	1.0	.9950	87.6	503	21,900	22,403
200	3.0	.9852	262.8	1510	21,900	23,662
400	0.5	.9988	21.9	126	10,950	11,076
400	1.0	.9975	43.8	252	10,950	11,202
400	3.0	.9926	131.4	755	10,950	11,705
1,000	0.5	.9995	8.8	51	4,380	4,431
1,000	1.00	.9990	17.5	101	4,380	4,481
1,000	3.0	.9970	52.6	302	4,380	4,682
2,000	0.5	.9998	4.4	25	2,190	2,215
2,000	1.0	.9995	8.8	51	2,190	2,241
2,000	3.0	.9985	26.3	151	2,190	2,341
3,000	0.5	.9998	2.9	17	1,460	1,477
3,000	1.0	.9997	5.8	33	1,460	1,493
3,000	3.0	.9990	17.5	101	1,460	1,561

Interrogators with MTBFs of 3000 hours or more appear to be cost effective. The total maintenance cost of the device during its service life of 8 to 10 years approximates the original purchase price of $15,000. An MTBF of 2500 to 3000 hours, for example, would provide monthly maintenance costs on the order of 1 percent of the basic acquisition costs, a standard basic for computating typical maintenance costs.

Consideration of MTBFs in excess of 3000 hours will obviously lead to even lower total maintenance costs with user convenience proceeding from excellent to outstanding. However, in this general area of MTBF values, the acquisition price of the units can be expected to increase. At present there is insufficient data to perform a reasonable tradeoff between unit price and MTBF across the MTBF range of 2000 to 4000 hours. Thus, it is impossible to calculate directly or to establish a range for design MTBFs based on a logical progression from established criteria.

However, since equipment is, in fact, designed to have a good percentage chance to pass a specified test, it is possible to apply the above discussion to a selection of a viable test plan from MIL-STD-781C. The general criteria for the selection of a test plan suggested by the foregoing are as follows:

- The test should eliminate interrogators with a 400-hour or less MTBF.

- Interrogators with 1000-hour MTBFs should have a modest chance of passing the test.

- Interrogators with a 2000- to 3000-hour MTBF should pass the test readily.

- The test should encourage the contractor to design the interrogator with the highest possible MTBF without resorting to the more complicated design techniques which would increase the production cost in steps to a threshold which would reduce the cost effectiveness.

- The test itself must not become an important factor in the cost of the development. The acquisition of MTBF data is only a portion of the test effort. The development test effort (DTII) and the operation test (OTII) both can be used as sources for operating hours to observe failures while other factors are also being examined by the overall effort.

The plans available in MIL-STD-781C should be examined. The criteria outlined above can be observed best in Test Plan 20-3. This plan when used with a minimum acceptable MTBF of 1000 hours will reject 200-hour equipment with great

certainty, has only a modest 20 percent risk for accepting a 1000-hour interrogator, and pressures the contractor to produce an interrogator with an MTBF in the 3000- to 4000-hour range. This test is used best in the DT/OT environment.

For the purpose of establishing actual values for the ROC document, it is possible to state with reasonable confidence that an interrogator which can demonstrate a minimum, acceptable MTBF of 1000 hours when tested to MIL-STD-781C, Test Plan 20-3, will produce acceptable results. Maintainability can be established by stating a mean-time-to-repair of 0.25 hour and by operator-type personnel using only common tools and appropriate replacement modules. By design, there will be no scheduled maintenance actions.

15. **Cost Comparison.** A baseline cost estimate for a 300-station system is shown in Table 4. These figures were extracted from the validated, life-cycle cost estimates prepared for the draft Required Operational Capability (ROC). Note that they are termed "baseline costs" because operation and maintenance are not included. The baseline cost estimate includes only capital investment costs. Because of stated concern for the cost of source-data-automation equipment, it was felt desirable to consider capital investment costs relative to other costs involved in the Defense Transportation System.

Table 4. Baseline Cost Estimate for a
300-Station System ($-Thousands)

Research and Development	2,345
250,000 Labels	6,884
200 Interrogators	2,954
25 Terminals	999
	$13,182

NOTE: 200 Interrogators with 600 antennas will yield 300 read stations.

The 300-station system was arrived at as a typical size that might be required for Army worldwide applications in the theaters of operations. This compares to a 900-station, DoD-wide system estimated in the WSEG study. The distribution of a 60-station system estimated for USAREUR application is shown in Table 5.

Over 50 percent of the capital investment shown in Table 4 is required to equip the 20- and 40-foot commercial container fleet. The $6.9 million would provide a sufficient number of labels to equip approximately 65 percent of the commercial fleet. At current peacetime volume, the 250,000 labels would last approximately 4 years assuming that half the commercial containers carrying labels are recycled to the Defense Transportation System. An additional 20,000 labels would be required for the remaining 6 years at an additional cost of $560,000.

A basic question that can be asked here is why should the Army expend $6.9 million to equip part of the commercial container fleet with source-data-automation labels? The answers stem from the rapid conversion of ocean-going fleet to container ships that has been experienced in the last 25 or so years and the recognition by DoD that it must rely upon commercial shipping resources to meet wartime contingencies.

Viewed in another perspective, for an $18 investment to place a single label on a commercial container, DoD has at its disposal a piece of equipment costing roughly $5,000 -- a leverage of capital resources on the order of 250 to 1. Considering the scarcity of capital resources in the peacetime environment, this is an attractive utilization of capital resources ignoring the storage and maintenance costs that would be associated with a comparable size DoD fleet.

The $13.2 million capital investment required to provide source-data automation is rather insignificant – slightly greater than 1 percent – compared to the $1.1 billion total DoD transportation costs experienced during fiscal year 1977. Typical DoD surface transportation costs are shown in Table 6 for fiscal year 1977 – a relatively light-volume year compared to the peak experienced during Vietnam which was approximately five times larger. The MTMC cargo-handling and documentation costs are subtotals of the DoD surface transportation costs. Finally, compared to the capital investment of $594.5 million for the Army's plan for container oriented equipment through fiscal year 1984, the $13.2 million is less than 2.5 percent. Improved efficiency anticipated from the application of CCIRS could pay for its costs.

16. Cost Benefit. In order to assess the benefits of introducing source-data-automation equipment in some quantitative sense, the costs of alternate methods were compared. This solved part of the problem leaving only the technical merits to be addressed from a qualitative approach.

Table 5. Distribution of 60 CCIRS Stations in USAREUR

Location	No. of CCIRS	Location	No. of CCIRS
TTP		Water Terminals (Port)	
Bremerhaven	1	Antwerp	4
Giessen	1	Bremen	1
Russelsheim	1	Bremerhaven	6
Nürnberg	1	Brindisi	1
Nahbollenbach	1	Genoa	1
Kaiserslautern	1	Hamburg	1
Boblingen	1	Leghorn	3
Mannheim	1	Nordenham	1
		Rhine River Terminal Complex	3
TSP*			
Kaiserslautern		Rotterdam	4
Bremerhaven	1	Taranto	1
Mannheim	1	Zeebrugge	4
MAC Terminals		Depot	
Rhein-Main	1	Germerheim General Depot	1
Naples	1		
		Einseidlerhof Medical Depot	1
Other Customer Areas	10	Giessen General Depot	1
		Pirmasens General Depot	1
Subtotal	23	Kaiserslautern General Depot	1
		Nahbollenbach General Depot	1
		Meisau Depot	1
		Subtotal	37

Total = 60

*There are 10 TSPs in USARUER; most of them have light traffic.

Table 6. FY77 DoD Transportation Costs[a] [b]

Surface Transportation Cost (OCONUS) (2,977,098 stons @ $388/ston)	$1,143,205,701
MTMC Ocean Terminal Handling Cost ($12.97/measurement/ton)	84,948,519
MTMC Documentation Cost ($4.83/measurement/ton)	31,634,654
DoD Detention Charges (estimated)	2,000,000

[a] Source: MTMC and Army Force Planning Cost Handbook.

[b] Source: MSC.

The four alternatives considered in generating operating costs, listed in their increasing order of capability, were:

- Pencil and Pad.

- CRT Digital Keyboard.

- Optical Light Pen.

- CCIRS.

The first alternative is the manual method presently used throughout the Defense Transportation System and is included here as the baseline system. The digital keyboard is also a manual method but it provides a real-time capability over the baseline system. Equipment is readily available to implement this approach in the form of computer consoles of the cathode-ray-tube type at a reasonable per-unit cost. The current ANSI/150 alpha-numeric standard code is also adequate to support this method without any modifications being required to the commercial container fleet.

The optical light pen is a semi-automated approach based on an optical bar code of the type being considered by the LOGMARS Group. It is operated manually, eliminates human error, and provides a real-time data capability. An optical bar labeled with the container identification number would have to be attached when the container entered the Defense Transportation System. Current light pens operate only at close ranges therefore imposing the constraint that checkpoints must be located so traffic can be halted momentarily. This constraint also applies to the two previous alternatives. Basic equipment costs for the light pen are higher than CRT costs; but,

the light pen is available on the commercial market. Inclement weather conditions might present problems such as freezing mud, but a properly equipped operator could eliminate these problems in a minimum amount of time.

The fourth alternative is the fully automated CCIRS with the capability of providing both error-free and real-time data. It is not available commercially and is the most expensive alternative to acquire. However, it is the most versatile of all the hardware alternatives considered in that it can monitor traffic which is in motion over extended offset distances. It requires the addition of a relatively expensive microwave transponder or label on the container which, again, increases the operating cost. Inclement weather conditions do not impose any operational problems. To estimate 10-year operating costs of these alternatives, a 300-station system was assumed to be operating in the OCONUS theaters in conjunction with a fully integrated, movement-management system similar to the conceptual DAMMS system. Some of the other basic ground rules and assumptions include:

● Gate-mode operations only so that traffic could be stopped to perform manual operations if required.

● A two-way traffic pattern at all gates to reduce manpower requirements.

● Existence of a communication network capable of supporting digital data transmissions.

● An operations schedule requiring a 2-shift, 5-day workweek.

● Personnel staffing was taken at the E-4 level giving a man-year cost of $12,500, which includes a 40 percent G&A factor.

● Monthly maintenance costs were computed at the rate of 1 percent of the acquisition cost.

● All assigned personnel were assumed to be dedicated to the traffic-monitoring function.

● Communication costs were considered equal and, therefore, were not included in the 10-year operating costs.

● Research and Development was not charged against the CRT keyboard or the Optical Light Pen.

● Capital investment costs were based on a $2000 CRT (the Hazeltime, for example, is roughly $6000), a $4200 light pen based on a LOGMARS cost estimate, and the CCIRS baseline cost estimate given in Table 4 which includes costs for only one label per container.

Personnel charges were assessed as half time for the Pencil-and-Pad baseline method to cover data recording, keypunching, and clerical staff support and full time for the other two manual methods. The full automated CCIRS alternative was assessed at 5 percent rates to cover periodic maintenance checks.

The 10-year operating cost, including capital investment, for the 300-station system is given in Table 7. Based on these figures and the ground rules and assumptions given above, the CCIRS alternative is cost effective in a peacetime environment. Compared to the current Pencil-and-Pad baseline system, CCIRS requires approximately 8 years to recover its capital investment and a little over 2 years compared to the other two manual methods.

Table 7. 10-Year Operating Cost Comparison for the 300-Station System ($-000)

	P&P	CRT	Optical	CCIRS
R&D	—	—	—	2,345
Capital Investment	—	600	1,260	10,837
Maintenance	—	720	1,512	3,910
Operations (Personnel/	(0.5)	(1.0)	(1.0)	(0.05)
Station and Total	37,623	75,246	75,246	3,762
Total	37,623	76,566	78,018	20,854

Constant-year 1978 dollars were used in this analysis making the comparison conservative to CCIRS. This results directly from the fact that the other three alternatives are manpower-intensive systems requiring more expenditures of funds over the 10-year time span as compared to CCIRS where the major expenditures are up front. Therefore, when inflation costs are added, CCIRS becomes more competitive. By the same token, however, "capital investment cost" − the value of drawing capital resources available for other requirements − is not considered, and this would offset inflation costs to some extent.

The peacetime cost effectiveness of the CCIRS is sensitive to the assumption that only one label will be required per container since more than half the resources are used to equip the commercial fleet. This is a real concern because one of the major problems encountered during testing of prototype equipment at the J-LOTS tests during 1977 was associated with the operational problem of loading containers backward on the wheeled chassis. This was particularly pronounced during Phase II where the DeLong Pier did not provide an orientation option during hookup. In this case, reverse loadings ran approximately 50 percent which is the expected probability for a two-sided event. Various solutions to this problem are available, such as reloading the container in its proper orientation as circumstances permit or placing a label on either side of the container. (The CCIRS interrogator requires line-of-sight visibility.) The later option increases the 10-year operating cost by $6.9 million which would increase its cost recovery period to 28 years — a time span too great to be considered cost effective from an economic standpoint. Also, technical considerations associated with the two-label option complicate the situation. Principally, the location of the interrogator would no longer be sufficient to provide necessary information on the direction of travel such as inbound or outbound. A similar case could also be made for the need of labels on either end of containers since some marshaling yards are set up for perpendicular parking thus increasing the requirement to a maximum of four labels per container. Other tradeoffs needed to resolve this issue include assessing the impact of sacrificing some coverage to compensate for reverse-loaded containers and reducing labels costs through cost learning curves based on larger sized production quantities.

Cost savings realized through improved performance of the transportation system (resulting from the availability of real-time and error-free data) were not considered in this cost-benefit comparison because of the lack of definitive data, although such savings could be substantial. For example, the ability to control the transportation, distribution system in real-time would insure its performance at or near its optimum efficiency, thus reducing the inventory level of transportation access as well as the supply inventory tied up in the pipeline. The ability to locate and expedite frustrated or critical cargo is an additional advantage of real-time data that is significant by itself. From interviews with active and retired logisticians, it was agreed that this capability is nonexistent in today's system. One of the principal objectives of the conceptual DAMMS system is to provide this capability; but questions remain as to whether it can be achieved with or without source data automation and of what value is it.

The improvements discussed above and others not cited would all tend to reduce the cost recovery period. Such improvements were not included because of the lack of definitive data on which to base the necessary calculations. It is understood that an assessment of the impact of real-time data on VIC performance will be

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attempted sometime during phase one. In the meantime, the significance of these savings can be illustrated by assuring some reduction in the annual MTMC documentation costs of $31.6 million experienced during fiscal year 1977. For a 1 percent reduction, these savings would amount to slightly more than a 1-year reduction in the recovery period bringing the total down to 6.6 years. Combined, the numerous benefits that can be reasonably expected from real-time data could bring the CCIRS cost recovery period down into the 2- to 4-year category.

Real-time control by definition is the issuing of orders or instructions in sufficient time to influence the outcome of the event. In the case of the Highway Fleet Management System (HFMS), real-time appears to be on the order of "tens of minutes" to as much as several hours. This is based on discussions with personnel familiar with the HFMS operation who stated that their primary concern was the lack of timely data — delays of up to 3 days were not uncommon. Delays caused by batch processing on a daily basis were of much less concern to these same people. Whatever the real-time requirement, it is impossible to control cargo movement through a dynamic network in a manner approaching an optimum situation without timely information. The more timely the information, the more efficient the operation of the system will be, thus reducing idle transportation assets. As the delay time increases to or surpasses the cycle time of the network, the control system becomes an information system and ceases to influence network performance except by identifying chronic problem areas that can be corrected by either procedural or organizational changes.

The basic benefits of CCIRS over the other three alternatives are listed in Table 7. In the opinion of the authors, the error-free, real-time capability of CCIRS and the potential improvements this system could provide in terms of a more effective, responsive transportation system under wartime conditions are much more important than its peacetime cost effectiveness. The term "error-free data" implies that an accuracy of 99.9xx% can be achieved by sacrificing some coverage through editing techniques. This is estimated to be less than 1 percent or so, based on the parity check bit contained in the alpha-numeric identification code. For an erroneous character to pass the parity check, compensating read errors, such as transportation, must occur. Chances of this occurring are extremely small. Of equal or greater importance is the large surge capacity which is especially significant during the transition phase. Again, definitive data on the effects of source-data automation on the operation and performance of the transportation system are not available to support this position. On the other hand, the experience gained from Vietnam and studies published since then tend to support this position as well as the special wartime considerations of increased cargo volume, the need for the movement-management system to interface with host-country support, and the highly fluid, dynamic situation expected on the future battlefield.

Some of the disadvantages associated with CCIRS include:

- Fielding of additional equipment.

- A manual backup.

- Vulnerable to enemy action.

- Requires a digital communications network.

Clarification may be required on the last two items. Although CCIRS may not be any more vulnerable to the hostile battlefield environment than personnel on a one-to-one basis, the overall system is more vulnerable from the standpoint that there are appreciably fewer replacement units in the theater and therefore the risk is higher. The requirement for digital communications may not necessarily be a liability relative to the total communications networks in as much as an automatic call-up, burst-type transmission, possible with digital data, could reduce communication requirements compared to current voice transmissions.

17. Another Option. An additional option that has been discussed from time to time is to wait for industry to develop and standardize a source-data-automation capability. A number of problems exist with this option. The first problem is an uncertain initial operational capability (IOC) date in that there is no current commercial activity known to exist and none is expected in the immediate time frame. A commercial manufacturer conducted a market survey several years ago and, although a sizable market was documented, the manufacturer concluded that the risk associated with getting the commercial carriers to adapt a system was too great. His chief concern rested with the fact that large segments of the market were controlled by a relatively few industrial councils any one of which could destroy the profit margin by refusing to adapt the system.

Second, even if and when industry develops and adapts an automated identification system, it may not meet Army needs because of the highly segmented nature of the commercial transportation industry and its own unique requirements.

Finally, a catalyst is needed. Industry has been conditioned to expect government support in high-risk areas, especially in those areas that overlap government requirements. The Merchant Marine Act of 1936 and the Defense Production Act of 1950, for example, are forms of this conditioning in which the government provides incentives for the maritime industry to make modifications to their equipment, which would otherwise not be accomplished, that are advantageous to the

national interest. Approached from this view with the condition that remotely read-able labels may be required to achieve rapid turnaround of containers in the theater of operations in order to support the commercial container fleet during a national emergency, the Maritime Act could provide the incentive necessary to equip the commercial container fleet.

18. **Other Applications.** A secondary objective of this study was to identify other applications for CCIRS within the Army so that development costs might be shared. In addition to this rationale was the aspiration by some that a major new application would be discovered which would guarantee the development of CCIRS. This, in turn, would make the system available to truck containers within the Defense Transportation System — a function or capability envisioned by many to be indispen-sable to a viable logistic system yet too expensive to introduce because of the cost of equipping the commercial container. This was not to be. Although several addi-tional applications were identified, none is sufficient by itself to warrant continued development of CCIRS in the opinion of the authors. In comparison to the $1.1 billion annual DoD surface transportation costs, the cost of the CCIRS is insignificant. The need for source-data automation within the transportation system must stand by itself.

Other applications examined during this study include:

- Pre-positioned War Reserves (Tactical Equipment).

- Movement and Control of Special Weapons.

- Logistics-Over-the-Shore (LOTS).

- Administrative Vehicle Fleet Management System.

- Intransit Cargo Security.

Although these categories were intended to be oriented toward applications outside the Defense Transportation System, several applications are closely related. LOTS, for example, was included because it represents a special set of conditions, hopefully of short duration, under which the transportation system normally does not operate. Again, the benefits of CCIRS toward reducing beachhead confusion in this environment could be significant.[30] This application, however, suffers from the cost of placing labels on the commercial container fleet as in the general case.

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[30] William O'Connor, et al., *Study of US Army Logistics-Over-the-Shore (LOTS) Operations and System Develop-ment*, AMSAA Technical Report No. 229, Aberdeen Proving Ground, MD (April 1978).

The Administrative Vehicle Fleet (an area entirely outside of the Defense Transportation System) could be of appreciable size and scope; however, it is suffering from such low priority today that resources have not been made available to even begin planning the management information system for which CCIRS would provide source-data automation. Basically, it is an inventory maintenance control system for the fleet of vehicles owned and operated by DoD and possibly other Government agencies. The control of special weapons and intransit cargo security are again special cases that exist within the present transportation system and will not be discussed. A separate study has been published on the application of CCIRS to the movement and control of special weapons.[31]

The use of CCIRS to track and monitor the location of the pre-positioned War Reserve is the only new application identified during this study. Even then, it is a minor variation to the Administrative Vehicle Fleet Management concept. A relatively few interrogators, appropriately stationed, could provide accurate, timely information as to the specific vehicles located within designated storage areas, the times they are moved, when and where maintenance was performed, and so on. There are always a few vehicles that cannot be accounted for when relying on manual information sources. Resources expended in attempting to locate these items could become disproportionately large. Intangible benefits of this nature could make CCIRS cost effective although they have not been analyzed. There are, no doubt, many other areas of potential application that have not been identified in this study. Although these additional areas may exist and others will develop in the future, it is doubtful that they would be considered sufficient on an individual basis to warrant continued development of CCIRS.

19. Actions Since Termination of CCIRS. The major findings and conclusions of this study were presented to the LOG CTR and Transportation School in August 1978. The primary purpose of this information briefing was to focus attention on the need to obtain an approved requirements document in order to continue CCIRS development during fiscal year 1979.

Based on a review conducted after the briefing, the LOG CTR concluded that a requirement did not exist for CCIRS, and the Transportation School was, therefore, directed to terminate actions designed to prepare a revised draft ROC.[32] The rationale supporting this position consisted of five major points:

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[31] *A Study of the Transition of DSS from Peacetime to Wartime,* The BDM Corporation, Vienna, VA (October 1976).

[32] US Army Logistic Center letter, 12 September 1978, subject: *Container/Chassis Identification Reporting System (CCIRS),* Fort Lee, VA.

- **Real-Time System.** The CCIRS, as designed, would provide data entry into the Visibility of Intransit Cargo and other system design actions involved in supporting the Department of Army Movements Management System. VIC is not a real-time system and, therefore, does not require a real-time input from a CCIRS.

- **Communications Dependent.** CCIRS is communications dependent. The demand for communications within the Army in the field is so great that logistics systems developments, insofar as possible, are being designed so they are not communications dependent.

- **Reliability.** While showing promise in the early developmental stage, the reliability aspects of CCIRS give the user considerable concern. Since the interrogator has as its basic advantage the complete elimination of the human element at the data-entry point, how will the system function in the event of hardware failure? Personnel at this Command and the Transportation School and those contacted in the 4th Transportation Brigade, USAREUR, have expressed the fear that equipment failures and communications failures might increase significantly in an active wartime theater.

- **Commercial Carriers.** Discussions with personnel familiar with the *potential for the use of a CCIRS-type system in civilian industry* revealed that one large container handler, the Sealand Corporation, has estimated that such a real-time, data-entry system might not be cost effective unless the system moved at least 3000 containers per day. Other discussions revealed that the American Association of Railroads has abandoned the development of a system similar to CCIRS since the payoff did not warrant the expense of development and operation of the system.

- **Acquisition Costs.** The potential payoff from CCIRS does not warrant the estimated expenditure of $13 million.

In view of the above position, development effort on CCIRS was terminated. However, a review of the above rationale revealed several points with which this study does not agree and which deviate to some extent from current Army documents. These will be discussed in the following paragraphs.

a.   **Real-Time System.** It is understood that VIC is being implemented without real-time reporting because the capability to generate and communicate real-time input is not available. In this respect, VIC as it now exists is not a real-time system. However, it is understood that VIC is being designed for on-line processing and inquiry. For example, the Adjutant General's tasking letter of August 1977 states that VIC is to " . . . be designed to allow on-line processing and inquiry and

operate viably in both wartime and peacetime environments . . . ."[33] In addition, a 4th Transportation Brigade manual on VIC, transmitted as Inclosure 2 to a letter[34] listing VIC and HFM as two possible applications of CCIRS, states in the systems description that:

> VIC is an automated operational/management information system for use by the Theater Movement Control Center (MCC) in a theater of operations. The VIC design concept calls for real-time operation, however, initial implementation occurred with the system operating in a batch-process mode. This was a result of hardware and communications network constraints in the European Theater. Additionally, actual operating experience in the batch-mode was deemed necessary to fully evaluate the impact of not having real-time and to assist in the justification of the expense of real-time.

> The VIC system, to effectively support the Theater MCC, must have an operating site that permits rapid response to the MCC and to sources of system input data. An efficient communications network permitting rapid data collection and file updates as events occur during cargo movement within the Theater is key to effective system operations. As in all transportation operations, data are time sensitive; if data reporting lags actual event occurrence, the system capability to assist the MCC Traffic Manager in operational decisions will be impaired.

In a subsequent letter,[35] the 4th Brigade stated that:

> Vic design efforts in the real-time arena have been concentrated on a capability to access the data base. Concepts to date have not envisioned "real-time reporting" of shipment location as performed by the CCIRS technology.

> The use of source-data automation is now under consideration. It should provide each input activity with an automated capability in addition to the data capture function. It will provide the redundancy required for a complete manual backup system.

> Based on the discussion above and on the realities of a contingency environment, the lack of CCIRS will have no impact on VIC status reporting by trailer control points. This command concurs with USA Logistics Center that the potential payoff from CCIRS does not warrant the estimated expenditure of 13 million dollars.

The value of having real-time output (e.g., access to the data base) without real-time input, as inferred in the second letter from the 4th Transportation Brigade, is not clear to the authors. In any event, if real-time input is required at some future time, the requirement should be stated now regardless of whether CCIRS is or is not a suitable, cost-effective solution.

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[33] Adjutant General's letter, *op cit.*

[34] DA Headquarters, 4th Transportation Brigade letter, dated 20 Dec 77, subject: *Micro-Marker Feasibility Study*, APO 09451.

[35] DA Headquarters, 4th Transportation Brigade letter, dated 20 October 1978, subject: *Container/Chassis Identification Reporting System (CCIRS)*, APO New York 09451.

b.   **Communications Dependent.** Although CCIRS, like VIC, is communi-
cations dependent, its main function is to automate source data. Therefore, in this
capacity, the CCIRS is more of an input device to VIC than a system unto itself.

If it is assumed that reporting of shipment locations will be done at
the same nodes regardless of whether the reporting is in real-time or in the present
batch-process mode. CCIRS will not entail the transmission of any additional infor-
mation; it will transmit the same information but much more frequently and in much
smaller batches. Communication requirements for VIC then should not be any greater
unless VIC uses manual data transmission means.

c.   **Reliability.** The CCIRS is strictly electronic hardware with no moving
parts and with some elements being completely passive. There is no reason to suspect
that the high reliability normally associated with such equipment cannot be built
into CCIRS. With respect to the impact of hardware failure, failures can be identified
in real-time and fixes applied within a reasonable amount of time. Some data will be
lost at intermediate nodes; however, since reporting at other nodes provides data
redundancy, this will have little effect on the overall usefullness of VIC if suitable
editing routines are utilized.

d.   **Commercial Carriers.** It is inappropriate to compare the present needs
of a commercial carrier to the needs of the Army's transportation system in Europe
during wartime. The degree of responsiveness required is far different. Commercial
carriers have little need for data for use in frustrating, diverting, and expediting ship-
ments. They are interested primarily in knowing container identification and location
in their marshaling yards for container shipment planning. Sealand has determined
that it is more cost-effective to inventory their marshaling yard manually unless the
number of containers on hand exceeds 3,000. As to the AAR effort, reports indicate
that the railroads would accept as cost-effective any reporting system which read
95 percent of the passing cars. However, they chose to develop a bar-code/reader
system which, because of the inherent limitations of an optical system, only reads
80 percent to 85 percent of the cars. For this reason, the railroads chose to drop
their development effort, and for this reason the Army chose to pursue a microwave
system.

e.   **Acquisition Costs.** The cost of $13 million is based on a worldwide
fielding of CCIRS and the placement of one label on each commercial container
entering the Defense Transportation System for the first 4 years of operation. Except
for the fact that it may be necessary to place two labels on each container, this is a
worst-case estimate. The use of CCIRS could be restricted to Europe, thereby reducing
the number of interrogators and terminals required and the number of containers
to which labels would have to be affixed. In addition, the number of intermediate

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reporting nodes within Europe could be reduced, thereby further reducing the number of interrogators and terminals required. These actions would significantly reduce the acquisition costs of CCIRS. Finally, with respect to costs, we recognize that when faced with a peacetime environment, a real-time capability may be difficult to justify on a cost-benefit basis although a comprehensive cost-benefit analysis has yet to be done. However, if CCIRS is needed in wartime, it must be developed now; and it must be exercised now at least to some degree. Use of CCIRS in peacetime on a limited basis, such as with CADS (Containerized Ammunition Distribution System) shipments, with the intent of expanding the use in wartime would be one possible approach to reducing costs and refining the system before expansion of its use.

In general, the authors feel strongly that the Army will need a real-time reporting capability to support its transportation network in any future war in Europe. Host-country support makes it even more critical that the Theater Army be able to locate containers and set movement priorities. The expenditure — $13 million — is large, but all values are relative and war is expensive. The critical issue that must be addressed at this stage is the wartime need. Resource allocation, the question of the relative worth of expending $13 million on CCIRS, cannot be considered in isolation but must be evaluated in the overall context of the Army's readiness and its Procurement Plan.

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